JANUARY 1941

The WELDING Journal

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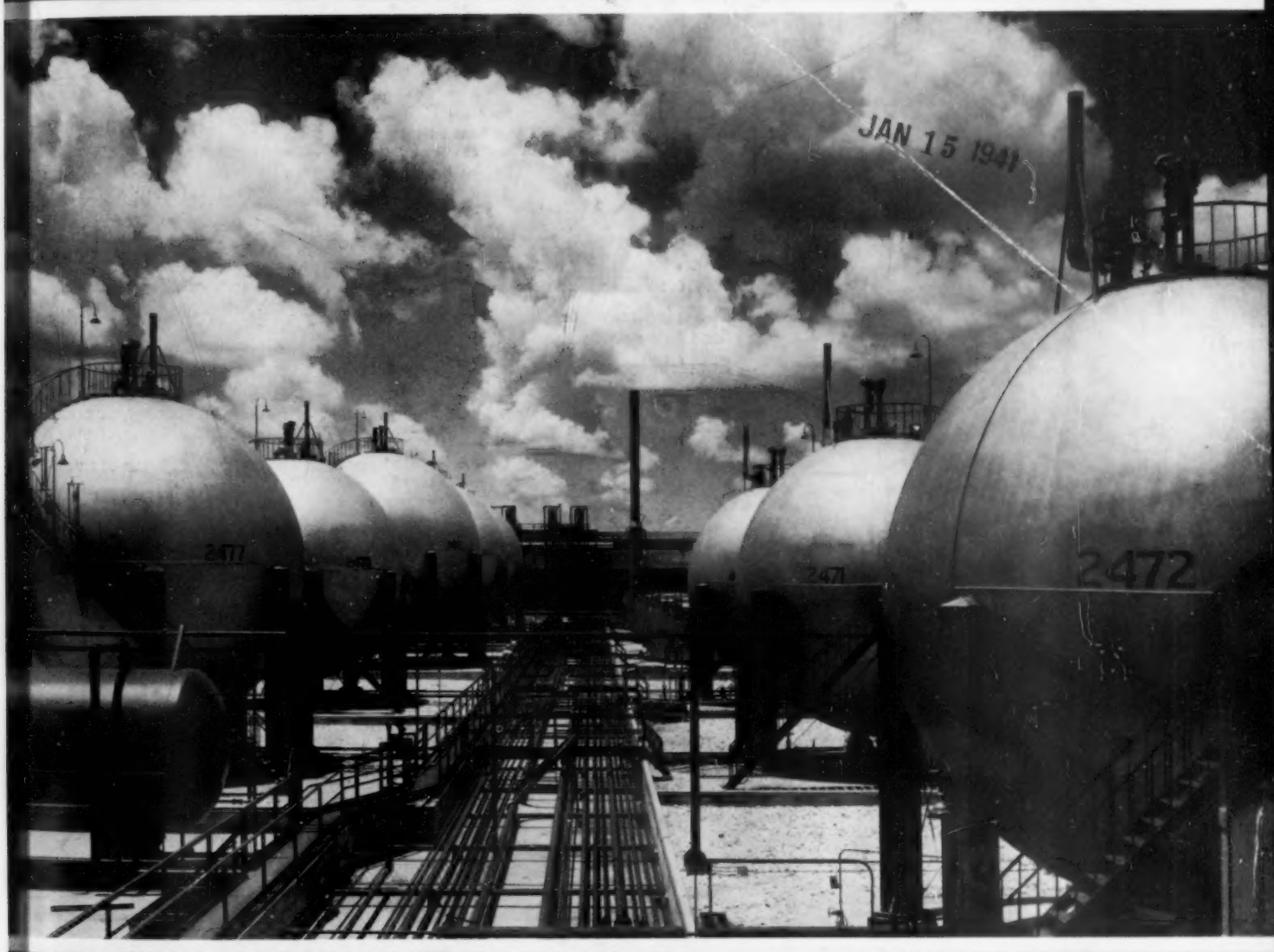
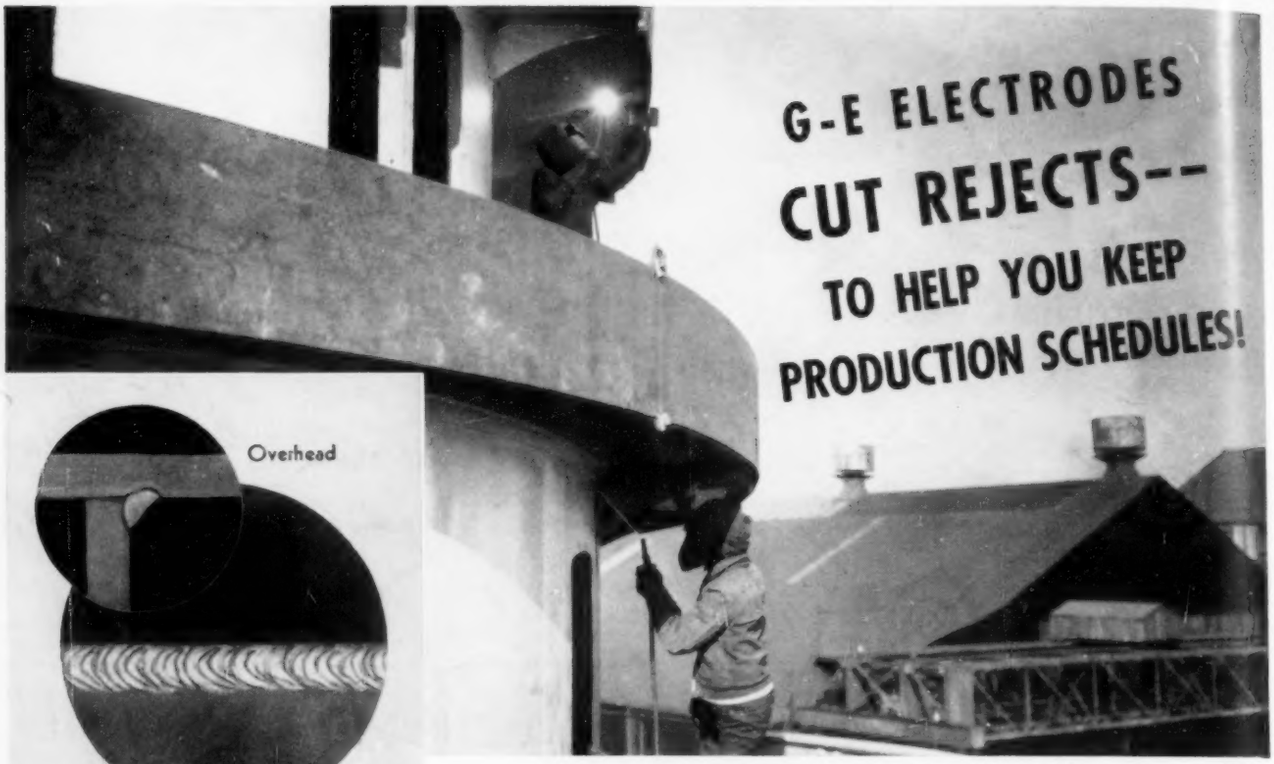


The Journal of the American Welding Society



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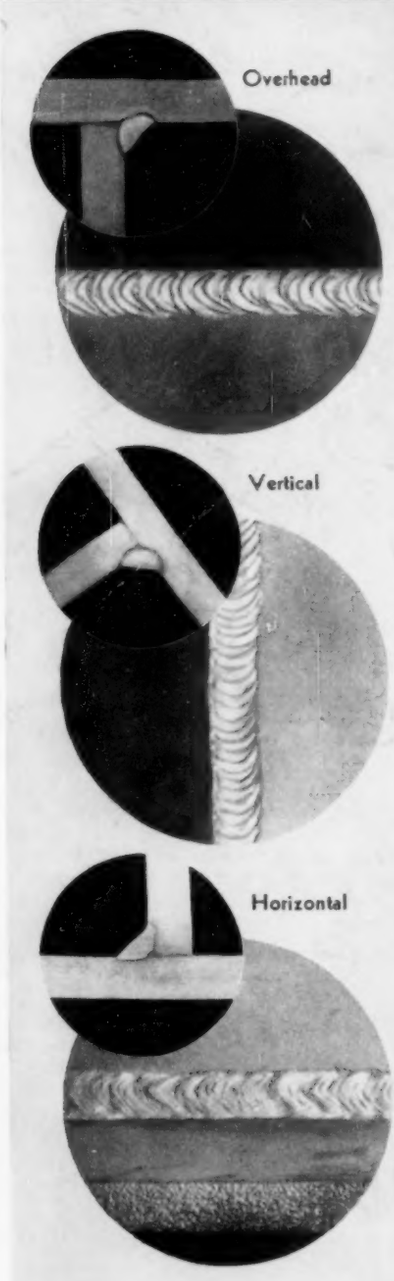

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JANUARY, 1941

Pipe Welding Burlington Generating Station*

By Philip Salmon†

IN SEPTEMBER 1938, at a meeting of the New York Section of the AMERICAN WELDING SOCIETY, a paper was presented by Mr. H. Weisberg entitled "Welding of High Pressure Piping at Essex Generating Station" which was a review of the use of pipe welding in Public Service generating stations from the first application at the Burlington Generating Station in 1932, and a statement of the practice that was followed at the Essex Generating Station in 1937–38. The paper was published in the November 1938 issue of THE WELDING JOURNAL. The purpose of this paper is to report on progress since that time with a few more facts about the Essex job and some of the more interesting features of the work now in progress at the Burlington Generating Station.

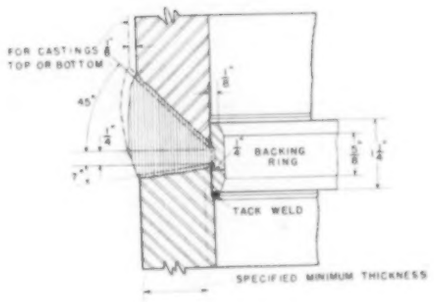
In general, the material to be welded, the sizes of the pipes and the scope of the work at Burlington are quite similar to the Essex job. The installation at Burlington consists of a 100,000 kilowatt condensing turbine-generator and two 550,000-pound-per-hour boilers operating with steam conditions of 1250 pounds, 950° F. at the turbine throttle.

Final figures have been compiled for the Essex job and they are interesting because they give us some idea of what it takes to put together the piping in a modern steam generating station:

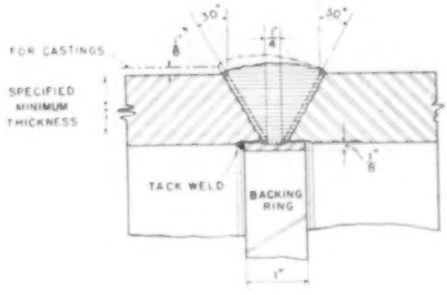
Field welds in pipe sizes $2^1/_2$ in. to 26 in.	3250
Field welds in pipe sizes 2 in. and smaller	5950
Total	9200

These welds have been in service since May 1938 and they have given no trouble to date.

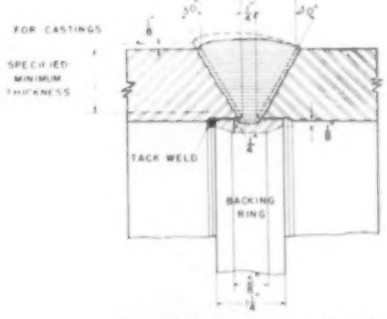
The tendency at Burlington has been to take advantage of every opportunity to simplify the work in the field in order to save time and money. For instance, at Essex a mineral-coated spiral-wrapped welding rod was used for joints in carbon-moly steel and a cellulose-coated rod was used for carbon steel. The techniques of depositing metal from these two types of electrodes are quite different; different kinds of backing rings were used for the two processes; the scarfing of the pipe ends was not the same; and, in addition to this, it was necessary to train and qualify some of the welders for two processes instead of one. At Burlington the cellulose-coated rod was used for both carbon-moly and carbon steel because by that time it had been tried and found suitable for our requirements. Furthermore, the carbon-moly rod was used for joints in both carbon-moly and carbon steel base metal,



FIELD WELDS FOR CARBON MOLYBDENUM PIPE
AXIS MORE THAN 30° FROM HORIZONTAL
WALL THICKNESS OVER $\frac{1}{2}$



FIELD WELDS FOR CARBON STEEL PIPE
WALL THICKNESS OVER $\frac{1}{2}$



FIELD WELDS FOR CARBON MOLYBDENUM PIPE
AXIS LESS THAN 30° FROM HORIZONTAL
WALL THICKNESS OVER $\frac{1}{2}$

Figs. 1 to 3—Butt Welded Pipe Joints Used at Essex Generating Station

* Presented at the October Meeting of the Northern New Jersey Section, A. W. S.

† Assistant Engineer, Electric Engineering Dept., Public Service Elec. & Gas Co., Newark, N. J.

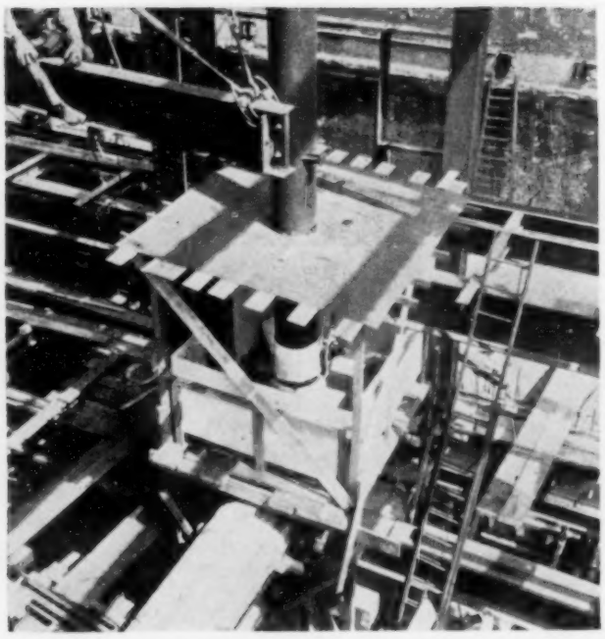


Fig. 4—19¼ In. O.D., 1⅛ In. Wall Thickness Boiler Downcomer

with only one type of backing ring and one scarfing detail. The joints used at Essex are shown in Figs. 1, 2 and 3. The detail shown in Fig. 3 was used for most of the joints at Burlington, except that the spacing was changed from ¼ in. to 3/16 in. At Essex, it was required that all preheated welds be maintained at or above the preheat temperature from the start of welding to the completion of the stress relieving. This requirement involved costly all-night attendance on some of the larger joints which could not be completed in one working day. At Burlington the operator is permitted to stop welding and cool off the joint slowly after three layers of weld metal have been deposited. No evidence of cracks was found in the joints that were allowed to stand overnight in this condition.

The socket type joint with fillet weld was used at Essex for the smaller high pressure piping, for sizes 2 in. and smaller. On the lower pressure pipe it was felt that a

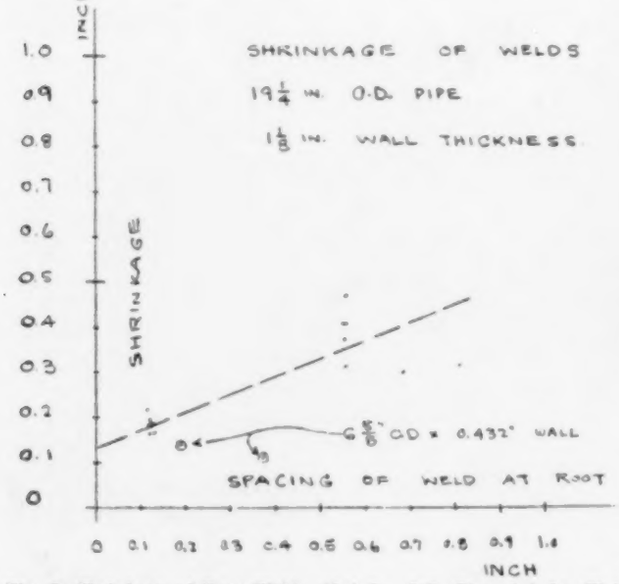
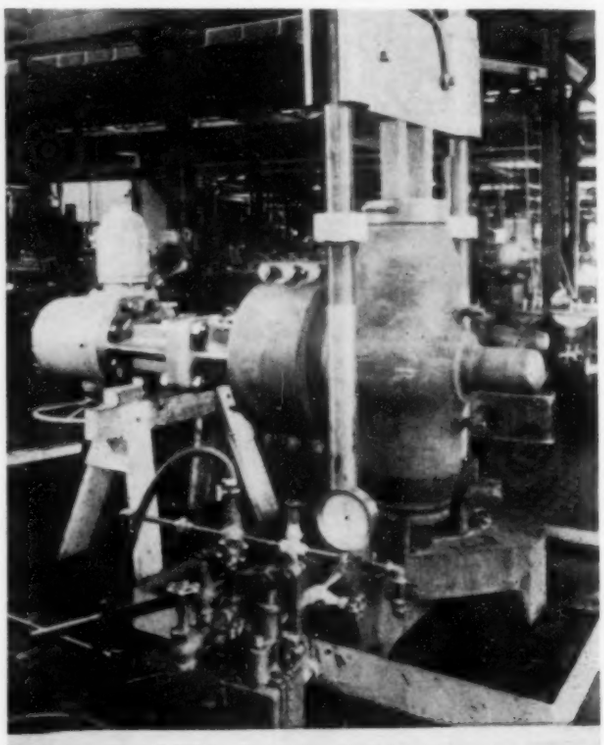


Fig. 5—Shrinkage of Butt Welds, 19¼ In. O.D. Pipe, 1⅛ In. Wall Thickness

weld joining the relatively thin wall of the pipe to the heavier wall of the valve or fitting might burn through the pipe, and therefore a butt weld without backing ring was used. One of the causes of this trouble was the fact that most socket welding ends on valves and fittings at that time were heavy screwed-end fittings bored out. By the time Burlington was started, fittings and valves

Fig. 6—Testing Body and Bonnet Assembled with Clamp Before Welding Bonnet Joint of 12-Inch 1500 Lb. Gate Value



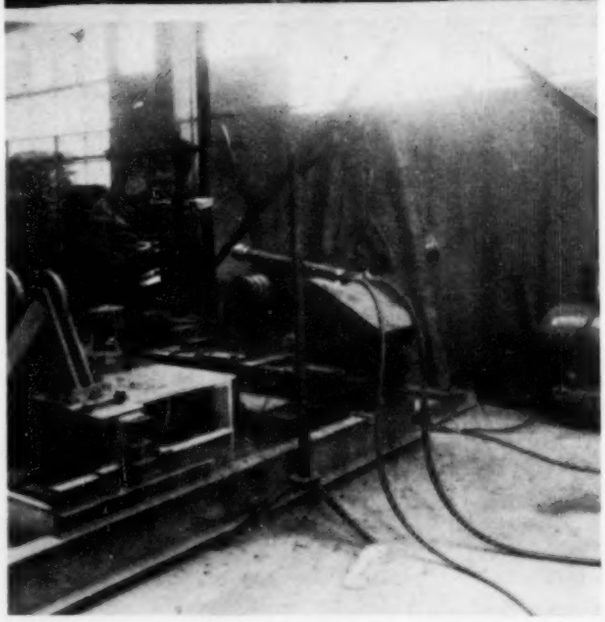
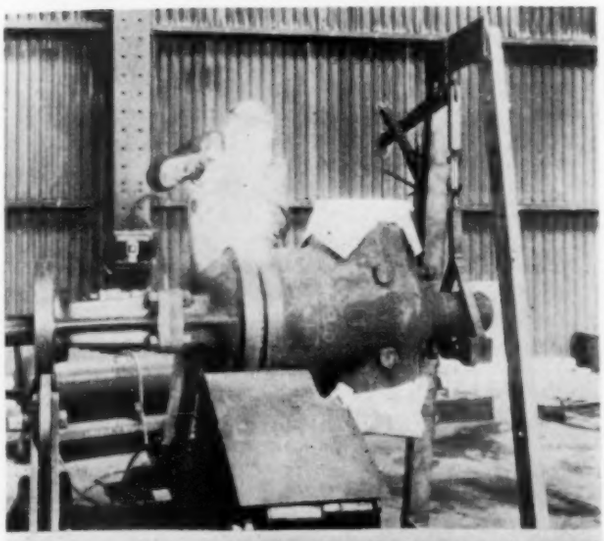


Fig. 7—Preheating Torch and Rigging for Rotating Valve During Welding

with socket ends specially designed for good distribution of welding heat were available and therefore they were used for all welded systems in sizes 2 in. and smaller.

The stress-relieving procedure for carbon-moly. at Essex was to heat the joint to a temperature between

Fig. 8—Weld Partially Completed



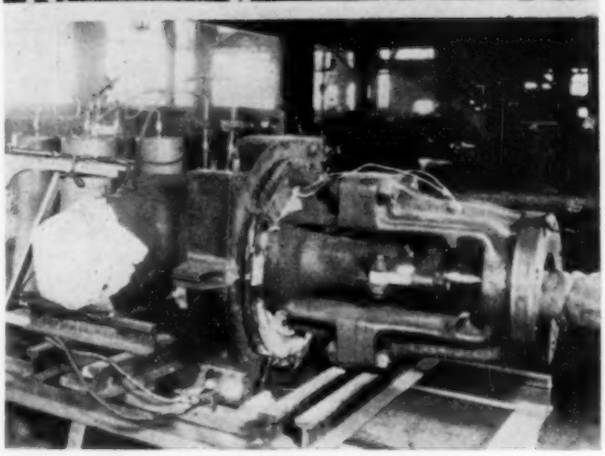


Fig. 9—Stress Relieving Welded Joint

1200° and 1250° F. for one hour per inch of wall thickness. The temperature range was changed at Burlington to 1150 to 1200° F. (50 deg. lower) for two hours per inch of wall thickness in order to have a larger margin between the critical temperature and the stress-relieving temperature.

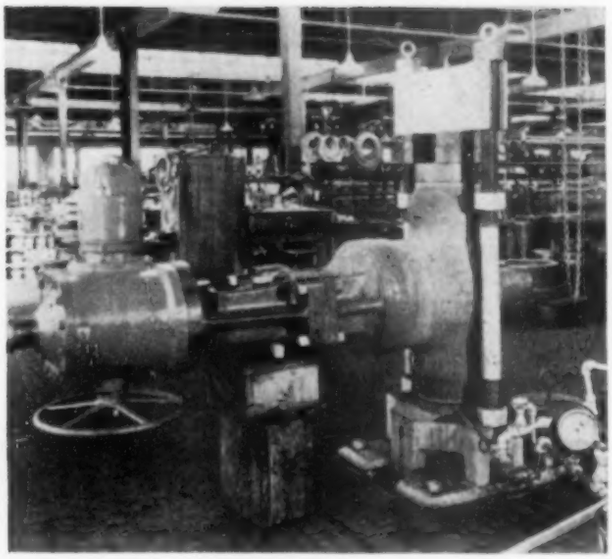


Fig. 10—Final Hydrostatic Test

By chance an unusual opportunity was presented at Burlington to observe the effect of the width of spacing at the root of the weld on the shrinkage of butt welds in heavy wall pipe. Each of the two boilers is furnished with two downcomers $19^1/_4$ in. outside diameter with a wall thickness of $1^1/_8$ in. (Fig. 4). These downcomers connect the upper and lower drums of the boiler with about 70 feet of straight pipe between the ends of the drums. In order to have the lower drum at the proper elevation after welding, it was necessary to estimate carefully the shrinkage in the two field welds in each downcomer. It happened that some of these downcomers were slightly short of the length necessary to line up the joints properly and consequently those joints had to be made with a wider spacing at the root of the weld. The others were furnished of the correct length and therefore we had the chance to make a comparison. The curve in Fig. 5 shows that the shrinkage increased as the width of spacing at the root increased. The amount of shrinkage,

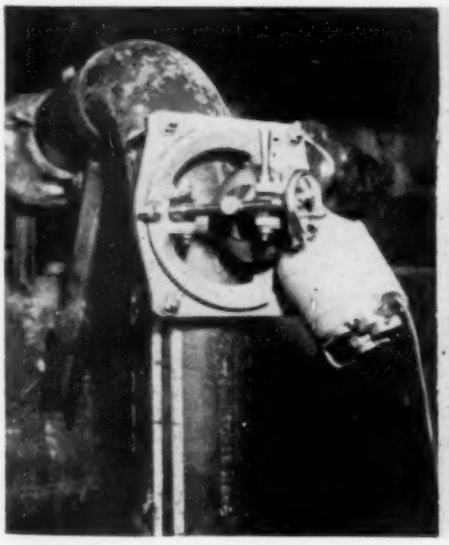


Fig. 11—Weld Prober Set Up on 8 In. Schedule 80 Pipe

Fig. 12—Cuts Made by Weld Prober

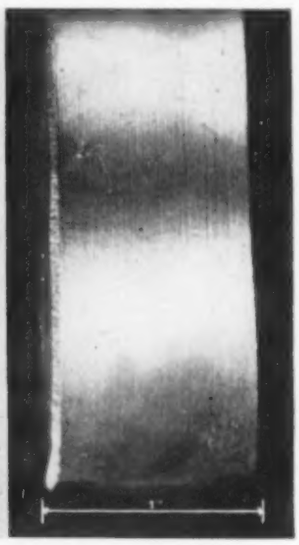


Fig. 13—Side Bend Test of Specimen Taken from Rewelded Prober Cut in $10^3/_4$ In. O.D. by 1 In. Wall Thickness Carbon Steel Pipe

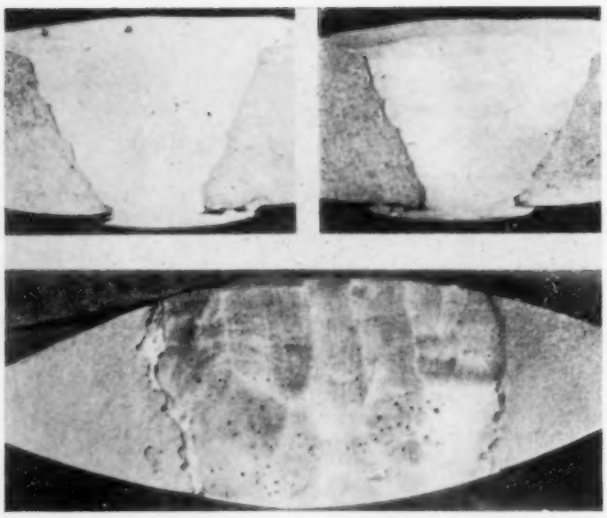


Fig. 14—Etched Specimen Taken by Weld Prober from Joint in 10¾ In. O.D. by 1 In. Wall Thickness Carbon Steel Pipe

of course, depends on various factors such as heat input, rate of welding, size of rod, etc. The two points below the curve show the shrinkage in a 6⅝ in. O.D. by 7/16 in. wall pipe.

On the Essex job, one of the six gate valves in the main steam piping was furnished with a welded joint instead of a flange at the bonnet. Since this valve has been satisfactory in service, all six of the new gate valves for the main steam piping at Burlington are of this type.

The various steps in the welding of one of these bonnet joints in the shop are shown in Figs. 6 to 10.

The weld prober is one of the newer developments that was used at Burlington. It is a portable, power-driven metal saw specially designed to cut a specimen from a weld (Fig. 11). The device is clamped to the pipe and set for the wall thickness. One cut is made and then it is revolved through 180 deg. and the other cut produces a boat-shaped piece of steel. The sample can be taken across the weld to include base metal and weld metal as shown in Fig. 12 or an all-weld metal piece can be removed by starting the cut 90 deg. from the position shown. The prober specimens from heavier wall pipe can be machined into a short tension test piece and tested readily. The cut is filled in with weld metal very easily. A side bend specimen was made from a rewelded prober cut in 10¾ in. O.D., 1 in. wall thickness pipe with good results as shown in Fig. 13. The face-bend test of a similar specimen taken from 12¾ in. O.D., ⅜ in. wall pipe passed the requirement that no defect should exceed ⅛ inch. The appearance of a deeply etched specimen taken from 1 in. wall pipe is shown in Fig. 14.

A large percentage of the field welds in a power-plant job such as Burlington are position welds. The space available for the welding machines is limited and often remote from the location of the joint. Many of the welds are made from scaffolds, and it is difficult for the welder to have ready access to his machine to adjust the voltage. This condition is a hardship for the conscientious welder and it slows down the job. At Burlington a portable rheostat was provided with each welding machine so that the welder can regulate it without breaking the arc (Fig. 15). As far as possible, pipes, fittings and valves are welded together on the floor and then hoisted into place (Fig. 16).

The location of field welds is a matter that must be watched carefully in the drafting room. The men who make and check the drawings must be careful to avoid field welds in quarters too close for welding. Sometimes it is unavoidable and the condition shown in Fig. 17 is the result.

The qualification of welders at Burlington was much simpler than at Essex because of the changes made in the AMERICAN WELDING SOCIETY Rules between 1937 and 1939. A guided bend tester was made on the job (Fig. 18) and the results of the qualification tests were usually known on the same day the test piece was machined. The cost of the qualification work was also proportionately reduced. The only real difficulty encountered in qualifying welders was in connection with a gas-welding process which was used to join the boiler superheater tubes to the superheater outlet header. The material is a 2 per cent chromium, ½ per cent molybdenum steel. It was necessary to make some changes in the

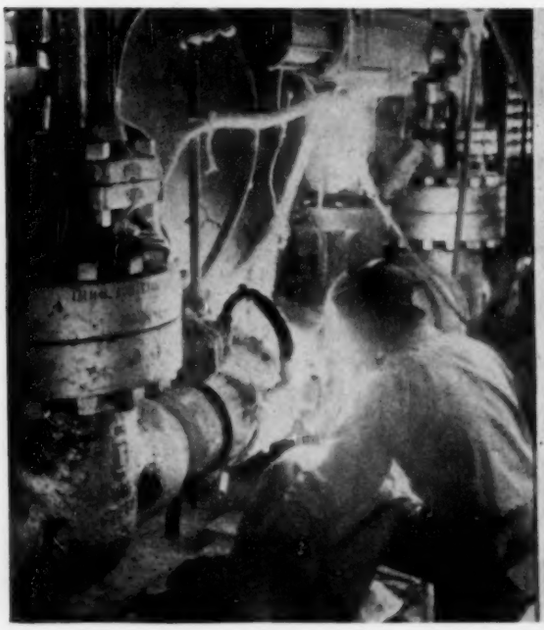


Fig. 15—Welder Using Remote Rheostat Control of Welding Machine

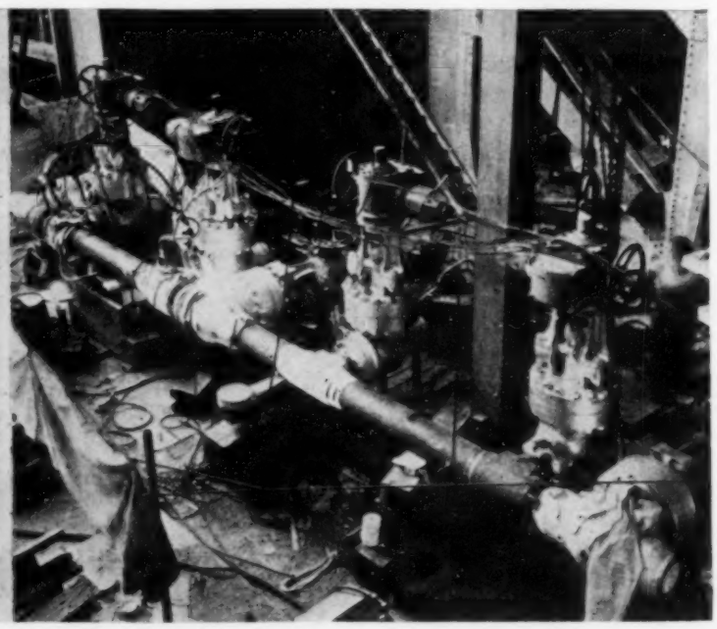


Fig. 16—Assembly of 10 In. Pipe, Fittings and Valves in 1750 Lb. Boiler-Feed System Being Welded on Floor Prior to Erection

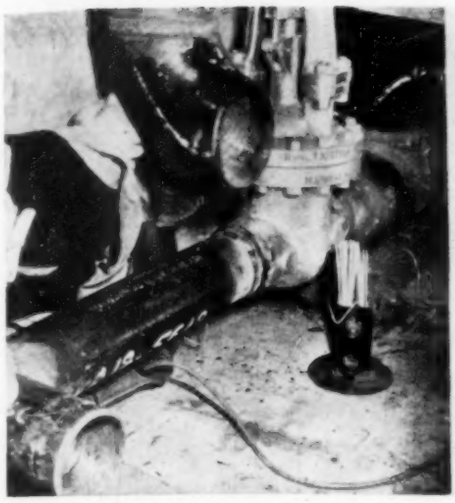


Fig. 17—Welding in a Difficult Position

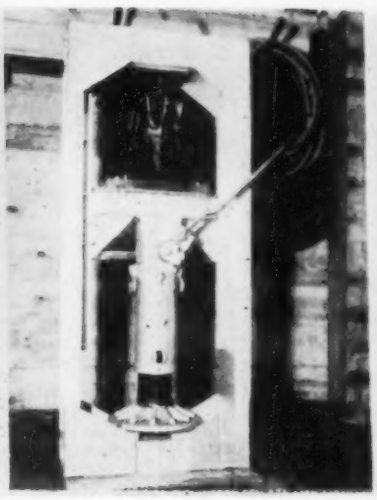


Fig. 18—Guided Bend Tester

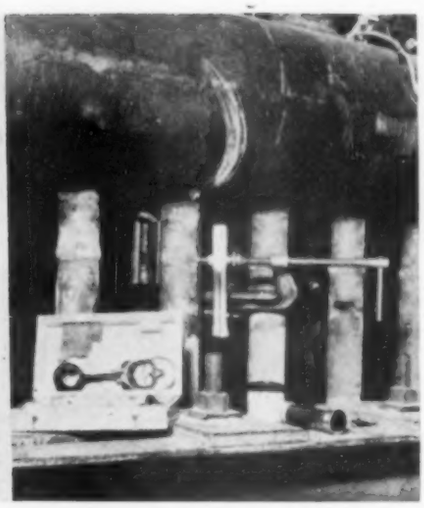


Fig. 19—Testing Hardness of Welds in Superheater Tubes Near Superheater Outlet Header

prescribed heat treatment of the weld before the specimens could be made to pass the guided bend test. These joints are in a difficult location for welding and it was very important that the welds be just right. In order to be sure that they were right, the hardness of these joints was tested by means of a portable hardness tester (Fig. 19). The device is clamped to a joint and a hardened steel ball is impressed on a ground spot until a predetermined pressure is attained. The diameter of the impression is a measure of the hardness.

Preheating and stress relieving at Burlington were performed in much the same manner as at Essex, by the electric induction method using 60-cycle, low-voltage current (Fig. 20). One of the interesting preheating jobs was performed on a field-welded joint in the shell of the condenser (Fig. 21). The temperature of the joint was raised from 40 to 125° F. before welding was started.

As required by the Boiler Code most of the field welds made on the boilers were inspected either by Gamma-ray or by the magnaflux method (Fig. 22). All of the joints but two, which were so inspected, proved to be entirely satisfactory. One of these was a surface defect and the other was a slag inclusion.

The piping was designed by the Electric Engineering Department, Public Service Electric and Gas Company; the field welding was performed by the United Engineers & Constructors Inc., Philadelphia; the piping was fabricated by The M. W. Kellogg Co., The Midwest Piping & Supply Co., and the Simmons Pipe Bending Works. Welded bonnet valves were furnished by the Lunkenheimer Co.

In conclusion, it may be said that the welding work at Burlington has shown progress in the effort to improve the quality of the welds, to provide the best possible working conditions for the welder and to reduce the cost of welding to a minimum. Further improvements are predicted as time goes on.

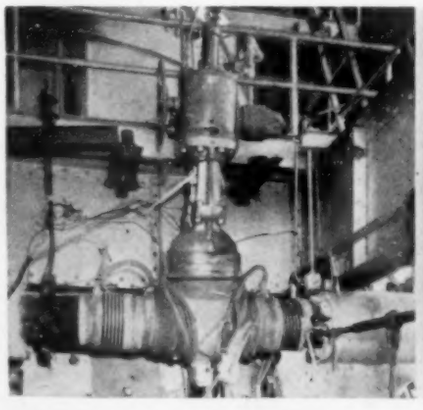


Fig. 20—Stress Relieving Line Joints on 16 In. 650 Lb. Main Steam Gate Valve

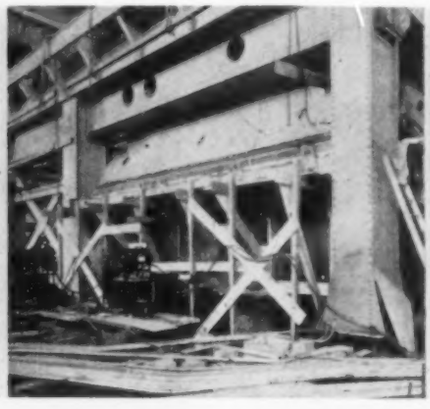


Fig. 21—Electric Induction Preheating of Condenser Shell Before Welding Longitudinal Seam Approximately 30 Ft. Long

Fig. 22—Magnaflux Inspection of Welded Joint in Boiler Piping

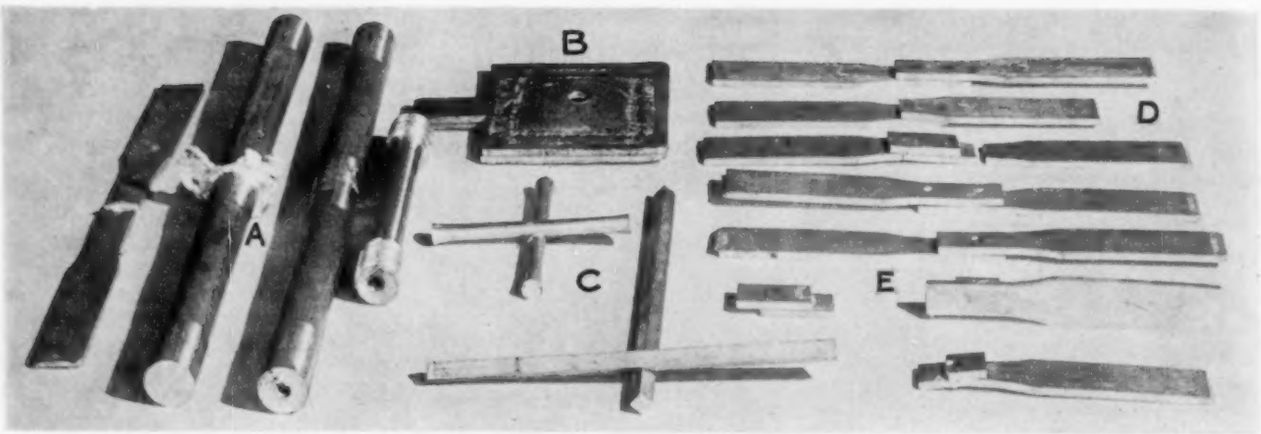


Fig. 1—Different Types of Welds

Resistance Welding Zinc-Alloy Die Castings

By R. T. Gillette*

IT HAS been generally thought that the zinc die-cast alloys could not be successfully resistance welded but enough preliminary work has been done to show that they can be successfully welded in many cases.

The use of pulsation welding was of considerable help in making many of the welds described. (This is a method of welding where the power is applied in several impulses instead of continuously. As an example, we may make a weld with eight impulses of power of five cycles duration with three cycles off between each impulse. This gives more accurate control of the various factors affecting the weld and, in the case of the lower melting point metals, better heat distribution without overheating, and, in the case of high melting point metals, better cooling and longer life of electrodes.)

The following types of resistance welds have been made: spot, projection, seam, cross-wire and butt. Attempts were also made to make stud welds, that is, to weld a small stud or bar on end to a plate. These welds were not very successful.

Figure 1 shows the various types of welds made. Group *A* shows butt welds made in flat bar and round rods including one standard machined test sample. Group *B* is two pieces, $^1/_8$ inch thick, seam welded around the outer edge. Group *C* is cross-wire type of welds in round and square rod. Group *D* is three spot-welded samples. Group *E* is four projection-welded samples.

The following description of the welding procedure and test results may be of interest.

Group *A:* Butt welds $^3/_4$ inch diameter round rod, welding procedure—current 19,400 amp.; time 2.3 sec.; pressure 670 lb. These specimens were then machined to standard $^1/_2$-inch test specimens as shown. The tensile strength average of three specimens was 22,220 lb. per sq. inch. The $^1/_2$ x $^1/_8$-inch specimens: butt-welded; no record kept of welding procedure; tensile strength average two specimens 39,000 lb. per sq. inch. The higher strength in the smaller section butt welded may be explained by the fact that small cross sections are always stronger in proportion to their area in tensile strength

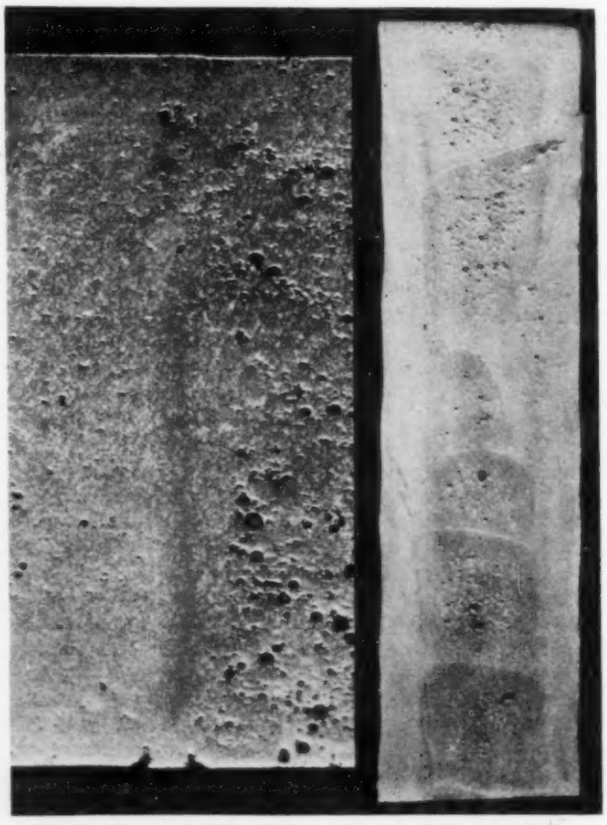


Fig. 2—Butt Weld on ¾ Inch Diameter Rod

Fig. 3—Longitudinal Section of the Seam Weld

* Works Laboratory, General Electric Company, Schenectady, N. Y.

Fig. 4 (Top)—Section Through Cross Wire Weld in the ¼ Inch Round

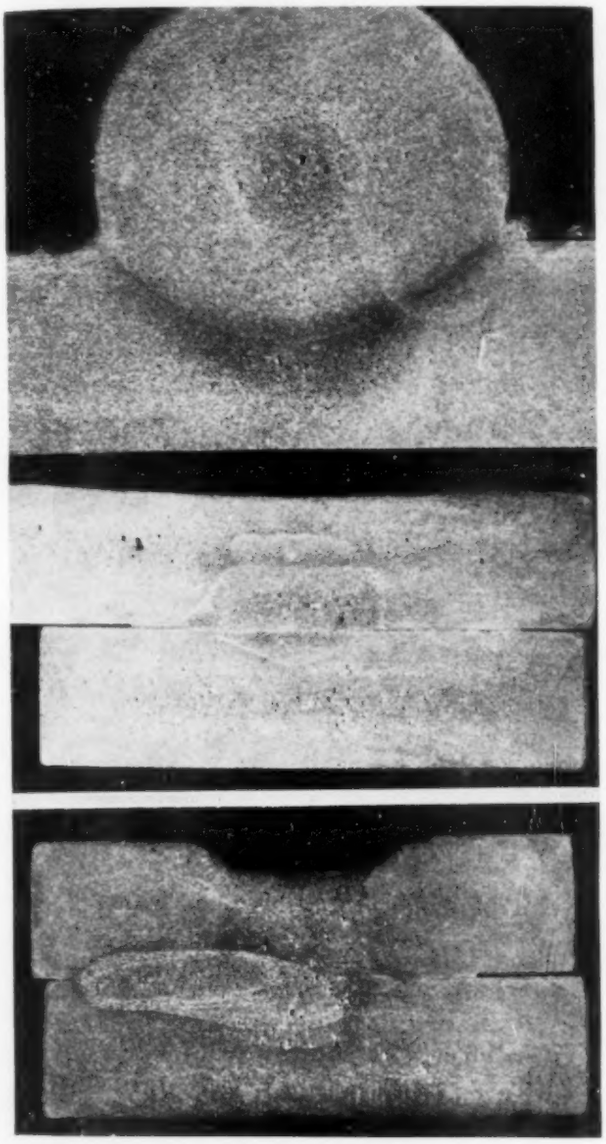


Fig. 5 (Center)—Spot Welding Through ⅛-Inch Pieces

Fig. 6 (Bottom)—Section Through Projection Weld

than larger cross sections because of the die cast skins. Figure 2 is a photomicrograph of a butt weld in the $^{3}/_{4}$ inch diameter rod, the breaks in the butt-welded specimens broke in the parent materials near the weld.

Group *B* is a seam weld made by welding all around two pieces of $^{1}/_{8}$ inch thick material with the following procedure: both wheels 9 inches diameter. Elkaloy with $^{11}/_{32}$ inch wide face; wheel speed 14 inches per min.; timing 33 cycles on 12 cycles off; current 19,700 amp.; pressure on wheels 1680 lb. welded under a flow of water. Test by screwing $^{1}/_{8}$-inch standard pipe nipple in one piece and applying water pressure to area 2 x 2 inches inside of weld. Weld was tight at 200 lb. per sq. inch pressure. Above this, pieces started to separate and at 300 lb. per sq. inch water pressure, nipple was forced out of piece, the weld still remaining intact. Figure 3 is a photomicrograph taken through a longitudinal section of the seam weld.

Group *C:* Cross wire welds crossing two $^{1}/_{4}$ inch round pieces. The following welding procedure was used: electrodes material as *B* grooved to fit $^{1}/_{2}$ the diameter of the rod. Pressure 130 lb.; current 7400 amp.; time, 8 impulses of power, 5 cycles on, 2 cycles off. Tests were made by bending two of the arms of the cross together until the material broke in the weld. The break showed good clean material but it was impossible to give the test a numerical value. Figure 4 is a photomicrograph of a section through the center of the weld in the $^{1}/_{4}$ inch round. The $^{1}/_{4}$ inch square pieces were cross wire welded with practically the same procedure and results as the round ones.

Group *D* spot welds: Welding two pieces $^{1}/_{8}$ inch thick and $^{1}/_{2}$ inch wide with the following procedure: $^{1}/_{4}$-inch diameter electrode point on one side and a flat electrode on the other, same material as *B*. Pressure, 230 lb.; current, 10,500 amp.; time, 3 impulses of power, 13 cycles on, 5 cycles off. Two welds in tandem broke in the parent material adjacent to the welds at 1400 lb. total load. Average of 2 welds. Single spot welds in shear broke at 1080 lb. total load, average of three welds. Figure 5 is a photomicrograph of a spot weld as described above.

Group *E:* Projection welds (a modified spot weld where the current is localized by projections on the material instead of a small cross section or point on the extreme ends of the electrodes) between two pieces $^{1}/_{2}$ inch wide and $^{1}/_{8}$ inch thick, welded with the following procedure. One projection 0.064 inch high, $^{1}/_{4}$ inch diameter, both electrodes flat face material as in *B*. 130 lb. pressure; current, 15,000 amp.; time, 8 impulses, 5 cycles on, 1 cycle off. Tested in shear 1135 lb. total load, average of three welds. The failures were all in the parent material, the bar breaking adjacent to the weld. Figure 6 is a photomicrograph of a section through a projection weld.

The above work was all done on the zinc-base die-cast alloy known as Zamak No. 5 which has a shear strength of 38,400 lb. per sq. inch in the parent metal. Some work has also been done on Zamak No. 2 and Zamak No. 3 and it is the author's opinion that No. 2 and No. 3 can also be welded using a slightly different procedure.

Some preliminary tests have also been made in spot welding sheet aluminum to Zamak No. 5. The results are very encouraging.

Fully synchronous electronic control was used on all the above welding and it appears that the use of this accurate type of control is necessary to eliminate the various inaccuracies of other types of controls, particularly transients caused by non-synchronous switching which would undoubtedly cause surface melting and expulsion of metal.

The use of pulsation welding gave better control of the various factors affecting the welds than the single impulse of power welding, particularly the overheating of the surfaces of the low melting point zinc alloy.

Conclusions

It is apparent from the results of the welding tests outlined above that, with the proper type of equipment and control, satisfactory welds can be made by the various resistance-welding methods provided the material is thoroughly cleaned and close tolerances adhered to in the welding procedure, such as the factors of time, current, pressure and electrode and equipment maintenance.

The use of welding should be of considerable value in fabricating various structures by welding together die cast parts to form an assembly which could not be cast as a complete structure or to reduce cost on structures which are difficult to cast in one piece.

Qualification Requirements for Welding Operators

EDITORIAL NOTE.—*The restriction of codes in regard to qualification of processes and operator requirements with attending costs are subjects on which there is divergent opinion. The* JOURNAL *is anxious to assist in crystallization of opinion and we are, therefore, publishing a communication from Mr. A. F. Davis, together with comments on this communication by key experts. Opinions expressed are those of the individual discussers and in no way commit either the* SOCIETY *or the organizations with which these discussers are connected.*

Communication from Mr. A. F. Davis*

IT IS generally recognized that only a comparatively small amount of welding is being done which can and should be done. This means there is a vast amount yet to be changed to welding. Since this is true, it is quite obvious that there are jobs waiting for thousands, yes, tens of thousands of welders in the future.

Why doesn't this tremendous amount of welding with its thousands of jobs for welders develop more rapidly? Well, partly because of tradition and largely because the progress of welding is being held back by every kind of laws, codes, rules, restrictions, etc., made and passed by Societies, City Councils, State Legislatures, Federal Authorities and anyone else who cares to. Everyone seems to have a hand in formulating rules covering welding. The unfortunate part about this is:

(*a*) Many rules and codes, etc., are unduly restrictive, and what is permitted in one code is restricted or forbidden in another, and vice versa.

(*b*) The cost of welding, due to test and unnecessary restrictions, is in many cases increased to the point where it is uneconomical and cannot compete with other methods.

Why do we have this more or less chaotic condition? Because the public has been led to believe that welding is something mysterious, that requires personal supervision of each welder and his work.

Such is farthest from the truth. Everyone who knows welding knows that a good welder (note, I say "good welder") furnished with proper material and equipment will consistently make welds that are stronger than the material being welded.

1. Is the trained riveter beset by checkers and inspectors on every rivet he drives?
2. Is the trained machinist harassed by supervisors on every operation of his lathe?
3. Do we X-ray every casting that is used?

We do not mean by this that really necessary precautions for safe, reliable welding should be eliminated. The point we are hoping to make is that the welder is not being given a break. We are not in any way trying to cast a reflection on him, as has been implied. What we are trying to do is to get the same acceptance for the work from a good welder, that is given to a riveter, a machinist and other recognized professions or trades. When that is done, the scope of welding will broaden tremendously and the call for welders will be far greater than the supply.

Comments

Dr. D. S. Jacobus (*Advisory Engineer, Babcock & Wilcox Co.*):

I cannot help but feel that all of us who have the interests of fusion welding at heart are aiming in the same direction in an endeavor to promote and safeguard its use and that while we may have different view-points our fundamental ideas are not as far apart as might be inferred from Mr. Davis' letter.

When all is smooth sailing, claims of the sort made in Mr. Davis' letter are apt to be overrated. A single major catastrophe in the use of fusion welding would place a different aspect on the matter; for example, the failure of the fusion-welded bridge in Belgium led to the following statements in an editorial published in *The Engineer* (London), June 17, 1938:

> "The accident to the Hasselt bridge provides a lesson and shows how much justified were the calls to prudence on the part of the welding specialists. To profit from the lesson, from now on structural engineers will not neglect any of the rules which are recommended, and the rules themselves will be codified with the collaboration of welding engineers."

It seems to me that our rules and regulations should be made to fit the possibility of rough and stormy weather as well as easy sailing.

In the paper which I prepared for the Annual Meeting of the SOCIETY in October on "Codes for Welded Pressure Vessels," I made the following statement:

> "The rules stated that the responsibility for securing safe welding rested on the manufacturer, who was required to test the welding operators. This principle is still maintained. The rules were more restrictive in some particulars than they might have been, the main idea naturally being to secure safety. Later on simplifications were made as the rules were tried out in practice."

The simplification of some of the rules is proceeding rapidly and every effort should be made to further the movement.

I do not agree with Mr. Davis that the progress of welding has been held back through the laws, codes and restrictions that have been made. As I have pointed out

* Vice-President, The Lincon Electric Company.

on previous occasions, the use of fusion welding increased very rapidly after the Bureau of Engineering of the Navy Department and the A. S. M. E. Boiler Code issued rules sanctioning its use for the drums and shells of power boilers which showed that the issuance of the right sort of rules helped in advancing the industry.

Mr. Davis says that everyone who knows welding knows that a "good welder," furnished with proper equipment and material, will consistently make welds stronger than the material being welded, and that what they are trying to do is to get the same acceptance for work from a good welder that is given a riveter, a machinist and other recognized professions or trades. He asks the following questions:

1. Is the trained riveter beset by checkers and inspectors on every rivet he drives?
2. Is the trained machinist harassed by supervisors on every operation of his lathe?
3. Do we X-ray every casting that is used?

My replies to these questions are as follows:

1. The quality of the work of a riveter for the better class of work is closely and constantly checked. In self-supporting steel stacks and similar structures it is good practice to tap every rivet to make sure it is properly driven, and in many cases some of the rivets are found to be loose and have to be redriven. In boiler drums and pressure vessels the hydrostatic test is a searching one on the tightness of each and every rivet.
2. There is no output that is as carefully checked in most cases as work done on a lathe and the machinist often has to work to very close tolerance limits.
3. It has been shown to be advantageous to X-ray or gamma-ray steel castings for certain classes of work and much useful work has been done in this connection.

We would all be very glad were it possible to inspect fusion welding in as simple and thorough a way as the products of the professions and trades listed by Mr. Davis. That inspection of fusion welding is necessary to secure the highest type of work is proved by the fact that where the joints are radiographed it has been found to be necessary to cut out parts of the joints made by the very best welders and procedures and reweld them, which shows that it takes more than what Mr. Davis has classed as a "good welder" to insure a perfect job.

Mr. Davis refers to a good welder but does not say how he would check up the fact that a welding operator is a good welder. There would seem to be no way of doing this other than by testing his work. We should cooperate in a movement to simplify and standardize the qualification tests of both processes of welding and the welding operators. There is no better way to do this than by working with the AMERICAN WELDING SOCIETY on the subject and clearing up the matter in a systematic and orderly way. Let us all stand together and lend a helping hand in maintaining the good record that has been achieved for modern fusion welding and in continuing its development and advancement along safe and sane lines.

C. E. Loos (*Carnegie-Illinois Steel Co.*):

When any new material or process is developed and promoted the user is always more or less skeptical of its merits. In order to use the new material or process the prospective user or group interested in its application write specifications or plan acceptance tests designed to protect their own interests. These groups of individuals cannot be expected to know as much about the new process as the promoter nor does the promoter know all of the details and facts pertaining to the users' application.

These specifications and tests may not always be the most simple ones. They may fail to give true values and also add some little cost to the work at hand, yet they serve well to convince the user in his own way of the merits of the new product or process. It is, therefore, believed that these many different specifications, codes, rules and restrictions governing the use and application of welding have helped in no small way to convince the skeptical and thus promote the use of welding on a safe, sound and economical basis.

It is, of course, highly desirable that the various welding codes and specifications be as nearly uniform as possible, but so long as there are differences of opinion among engineers, we cannot hope to find a closer agreement in welding codes than exists in other private, municipal, state or federal specifications. There has been a definite tendency to add more tests and restrictions and to tighten up in general on all specifications covering materials and processes, so why should we expect to find a "let-down" and a greater uniformity in welding specifications? However, the AMERICAN WELDING SOCIETY is making every effort to simplify and to write sound and practical welding specifications.

A great deal has been said and written concerning the need for the qualification of welders, for it is a subject that is of utmost importance in the preparation of a welding code or specification. It is believed that the requirement by practically all welding specifications for the employment of properly qualified welders has been one reason for the rapid growth and wide acceptance of welding.

The skill of the welding operator is commonly recognized as an important factor in the joining of metal parts by the metallic arc process, and while welding equipment and materials have been perfected to a marked degree, there is still the human element to be considered if safety and good workmanship are to be attained.

It is true that the procedure for qualifying welders can be made quite elaborate and costly, but specifications governing such procedure usually aim to have the welder produce the same standard of workmanship as is necessary for the class of work that it covers.

It is sometimes charged that discrimination is made against a welder, and that other skilled workmen are not beset by checkers and inspectors or harassed by supervisors. This, of course, is not true. The trained riveter who serves a long training period, starting first as a heater, has his rivets inspected by a shop rivet inspector and again by the purchaser's representative. He works under a rivet foreman as well as a superintendent. Likewise, the trained machinist and other skilled mechanics who serve much longer periods of time than welders, as apprentices, are subject to supervision and their work to close inspection.

A good welder should welcome qualification tests and inspection of his work. It gives him an opportunity to demonstrate his skill and prove to his employer that he can consistently do good work. Qualification tests for welders should be made as simple as is consistent with the class of work that the welder is called upon to do, but in no case should the importance of obtaining good workmanship be minimized and welding permitted to be done without proper inspection or by unqualified welders.

Where the class of work permits automatic welding and where the human element plays but a relatively small part in the actual welding operation, it is believed that the welding process should then be subjected to a qualification test and such a test repeated only when a change has been made in materials or in the welding procedure.

H. C. Boardman (*Chicago Bridge & Iron Company*):

The desire of Mr. A. F. Davis for more welding is natural and commendable. His impatience with overlapping, conflicting and sometimes unduly restrictive rules, specifications and codes is easy to understand and is shared by many enthusiasts who would like to see welding advance with fewer safeguards than have been and are now thrown around it. But is it not true that these very rules, specifications and codes which during impulsive moments seem barriers to welding, are often found, upon reflection, to have contributed largely to its marvelous growth? Have they not made welding safe during a period when a few major failures might have more than offset all progress previously made? Is it not better to advance slowly and conservatively, proving each step, than to recklessly plunge ahead? Is there upon us any compulsion to universally adopt welding almost overnight? Would not such an event throw out of employment men used to riveting, giving industry generally insufficient time to adjust itself to welding?

A reader might get the impression that Mr. Davis believes the skill of the operator in manipulating the arc is practically all there is to welded construction, but nobody knows better than he that many other factors are involved, such as the selection of the material to meet the service conditions, preparation for welding, the methods of assembly, welding sequence and procedure, treatment after welding, and inspection and testing of the completed structure. Welding low carbon steel is one thing, welding high carbon steel is quite another. Alloy steels and non-ferrous metals present their own distinctive problems. It is largely such factors, and not operator qualifications alone, that welding codes cover.

In his protests Mr. Davis is strangely silent about the work of the AMERICAN WELDING SOCIETY in standardizing welding rules. Of its many publications, the following are typical:

1. Welding Symbols.
2. Welding Definitions.
3. Mechanical Tests of Welds.
4. Standard Qualification Procedure. This requires the qualification of both procedure and operators. Undoubtedly, as procedures become established their qualification by individual contractors will become unnecessary and not be required. Furthermore, in cases where adequate and economical tests of completed structures can be devised, procedure and operator qualifications may safely be omitted.
5. Specifications for Iron and Steel Arc-Welding Electrodes.
6. Rules for Field Welding of Storage Tanks. These are incorporated in the A. P. I. Stds. No. 12-C for Welded Oil Storage Tanks, and the A. W. W. A. Rules for Welded Elevated Water Tanks, Standpipes and Reservoirs. Certainly these rules and specifications are effective in promoting the use of welding.
7. Specifications for Welded Highway and Railway Bridges.
8. Code for Fusion Welding and Gas Cutting in Building Construction.

Nearly everyone familiar with these publications, and others like them, is convinced of their value in promoting uniformity in welding practices. Furthermore, the AMERICAN WELDING SOCIETY is represented on conference committees with many organizations, among them the A. S. M. E. Boiler Code Committee, the American Petroleum Institute (A. P. I.) and the American Water Works Association (A. W. W. A.), and is working with the American Standards Association (A. S. A.). U. S. Army and Navy engineers are cooperating with the SOCIETY in the formation and promulgation of codes.

Likewise the A. S. M. E. Boiler Code Committee and the National Board of Boiler and Pressure Vessel Inspectors have long and effectively cooperated in obtaining a large degree of uniformity among the states in the design and construction of welded boilers and unfired pressure vessels.

Evidently forces are actively engaged in combating the tendency toward the "more or less chaotic condition" which Mr. Davis deplores. He may be assured that all informed engineers approve of his objective although they may not wish to travel toward it as fast as he does or on exactly the same road.

A. G. Bissell (*U. S. Navy Dept., Bur. of Ships*):

This reply should also be considered a reply to Mr. Davis' letter and the many articles which Mr. J. F. Lincoln has recently published under the headings of "An Arc Welding Fallacy," "No Mystery in Arc Welding," etc. Since I am one of the "witch doctors" to whom he refers, I should be permitted to say something in defense of welding procedure control, which Mr. Lincoln has dubbed "the art of the medicine man."

Mr. Lincoln and Mr. Davis have apparently started a crusade against unnecessary tests. Broadly speaking, I concur with their points of view, but must differ with them in regard to many of the details which they have brought out in support of their arguments. Unnecessary costs are to be deplored, but it must not be assumed that all welding tests are unnecessary costs. While I am fully in accord with the general principle of the simplification of codes and welding test requirements and am doing all in my power to unify qualification requirements and other requirements, I consider that these very codes which Mr. Lincoln and Mr. Davis deplore have been the most vital influence in the safe and systematic development of arc welding.

The rapid application of arc welding to important fabrication operations could never have been accomplished with safety had these developments proceeded without careful control of each step of the process.

The following question and answer arrangement has been used to reply to the direct questions raised in Mr. Davis' letter:

Mr. Davis' question: Do we X-ray every casting that is used?

Reply: Radiographic inspection of welds is required only rarely, for the control of welds subjected to very high stresses or intended for very hazardous service. Similar requirements are in effect for steel castings when they are highly stressed or subjected to hazardous service. The majority of the welds, and castings too for that matter, are used without radiographic examination.

Mr. Davis' question: Is the trained riveter beset by checkers and inspectors on every rivet he drives?

Reply: Riveting operations have always been subject to very careful control in the construction of Naval vessels. As a matter of fact, a specification for riveting has been in effect for a much longer period than is the case for the welding specification.

Mr. Davis' question: Is the trained machinist harassed by supervisors on every operation of his lathe?

Reply: The work of machinists is also subject to inspection and checking for dimensional accuracy. It is believed, however, that machining operations,

while important, are in an entirely different category than the hot fabricating operations, such as riveting, welding and casting, and therefore need not be subject to such careful control as these latter operations.

I do not believe that we should confuse the issue of welding control with the fact that many jobs would be available for welders if these controls were relaxed. It is not likely that an increase in total employment would result, inasmuch as the jobs of artisans in other crafts would be replaced, and there would probably be fewer man-hours of welding than there had been for riveting, molding, pattern making, etc., if it is true that an economic advantage would be produced by using welding.

Welding engineering, as I see it, has two principal functions; first, to safeguard the integrity of the welds that are made, and, second, to simplify the operation so that the work will be easier for the welder. Proper joint preparation, positioning of welds, study of sequence of operations, selection of materials which do not have to be highly preheated, are all in line with this second feature of making the work simpler for the welder. While it is true that the operation of welding has also been made simpler by proper welding machinery and the development of covered electrodes, these other features which I have mentioned should not be overlooked when there is a tendency to condemn those responsible for the control of welding operations.

Although many innovations have been made to make the work of welders simpler during the past ten years, I cannot concur with Mr. Lincoln that the only thing a welding operator has to do "is to hold the end of an electrode at a certain distance above the deposited metal and advance it along the seam to be welded at a certain speed." It is an insult to the intelligence of the welding operators to consider them as mere automatons or robots. In controlled welding practice it is desirable that the welder be trained to follow a procedure as laid down for him by his supervisors. It is also desirable that he have sufficient intelligence and ingenuity to recognize troubles and deviations from the procedure when they occur. In this connection, it appears to me that this concept of the welder's function "gives the welder a break" much more than the "rod burner" concept which Mr. Lincoln is trying to popularize. A really good welder is given more of a break by the present system of qualification tests than he would have if years of service were the only gage of his ability in his craft.

In conclusion, I should like to say that I am in accord with the idea of establishing standard procedures for ordinary carbon steel welding so that shops which adopt these standardized procedures need not go through a qualification of welding process. On the other hand, I can understand the point of view of those engineers who are dealing with industries where welding is the exception rather than the rule. If a shop has not done welding of any kind whatsoever, it may probably be desirable to have a process qualification test, even though it is of the simplest kind, namely, welding of carbon steel. I think this should be left up to the committees of the various engineering societies.

This represents only the opinions of the writer and not the opinion of the Bureau of Ships or the Navy Department.

Chas. H. Jennings (*Westinghouse Electric and Mfg. Co.*):

Mr. Davis has stated that the application and growth of welding is being greatly retarded by the many laws, codes, rules, restrictions, etc., established by regulating bodies. In addition to this, it is mentioned that a good welder furnished with the proper material and equipment will consistently make welds stronger than the parent material, consequently his work should be given the same acceptance that is given to a riveter, a machinist and other recognized professions or trades.

Both of these statements are probably correct but they need further amplification.

Welding codes, regulations, restrictions, etc., are not made in an effort to hamper or restrict the application of welding. Their prime purpose is to aid in insuring the production of a satisfactory product. Also it is not the intention of any code or specification to penalize a good welder. It is the intent of codes to determine which welders are "good welders" and to set up the necessary requirements so that only good welders can work under the code.

The many overlapping codes and specifications on welding are undesirable and annoying to the fabricator, not because they restrict the use of welding, but because they cause unnecessary expense in the duplication of qualification tests. The cure for this trouble is not to do away with all codes but to simplify and combine them, a task which the AMERICAN WELDING SOCIETY is now attempting to do.

To date the lack of welding codes is probably more responsible for limiting welding applications than the existence of too many codes. Restriction of welding in building construction is a typical example.

If every welder was a "good welder" and every designer an expert, we probably could eliminate many codes. This condition will never occur, however, consequently the industry must have specifications and codes to insure satisfactory welded structures. The answer to the entire problem, therefore, is for the AMERICAN WELDING SOCIETY to prepare standard codes and specifications that are simple and efficient and that will be accepted by the industry at large. These codes will replace many of the special codes now in force. Such codes will not retard welding but will actually increase its use because the purchaser of welded equipment and products will have increased insurance that welded structures, machines, etc., are the best he can buy.

K. V. King (*Standard Oil of California*):

It is not quite clear to me where the jobs for "tens of thousands of welders" are going to come from except by an increased amount of construction or by replacement of men involved with other means of fabrication. Naturally, as an increase in construction of buildings, ships or what-not takes place, an increased number of welders, however, who are doing fabrication that was formerly done by some other means than welding, are simply replacing those who would do riveting or brazing, forming or casting, etc. The "jobs waiting for thousands" simply means other thousands out of jobs unless the over-all requirement is increased. Mr. Davis is looking on the side of the picture in which the sun is rising and forgetting that the sun is also setting in another part of the picture. It is well to keep one's eyes toward the rising sun, toward the new and improved, but one must not forget that changes, even though desirable, may meet opposition and constructive efforts may have to be put forth over many years' time to bring about known desirable ends.

There are usually two sides to every question. There are usually several points of view to every controversial issue. While it is easy to make broad, challenging criticisms of an unsatisfactory situation, be it technical, economic or political, it is doubtful that constructive solutions can be reached without careful evaluation of

the different points of view and forces involved.

I, for one, will say that welding has only reached its present state of general acceptance because there have been specifications, inspection and control over the methods employed. Even with these means of endeavoring to assure the adequate quality of welding, there have been instances when such control was either inadequate or relaxed and poor quality of workmanship resulted. However, this does not mean that in some instances such control may not have become too complicated, too contradictory and burdensome.

Mr. Davis raises three questions, in which he suggests that craftsmen on other types of metal fabrication are not subjected to the inspection that welders receive. Possibly a little analysis of the comparative examples he cites will indicate that they are not very comparable.

He asks, "Is a trained riveter beset by checkers and inspectors on every rivet he drives?" The answer, I believe, would be "no." On the other hand, this does not mean that riveted construction is not very commonly subject to critical inspection. It is recognized that if the set-up for riveting is properly made, holes are adequately lined, the choice of rivet size, material, and riveting tools has been properly made, and the riveter has had a reasonable amount of experience, there is not a great deal that can go wrong. After the riveting is done, the quality of workmanship can be checked fairly accurately by cursory, visual inspection, and tapping the rivets with a hammer. I have known such inspection after riveting to result in the requirement that 50 to 75% of the rivets be redriven. I do not believe that the situation is comparable to welding, and I don't think Mr. Davis would have us believe that you can determine the quality of a welded joint by simply tapping it with a hammer.

Mr. Davis asks, "Is the trained machinist harassed by supervisors on every operation of his lathe?" The answer is "no," but, on the other hand, the quality of the work which a trained machinist does can be accurately determined by simple measurements of the finished product. Does Mr. Davis indicate that we have reached that hoped-for stage in determining the quality of welding workmanship?

Mr. Davis asks, "Do we X-ray every casting that is used?" The answer is generally "no," although it is believed that certain airplane companies are actually doing just that. In general, the first few castings for severe services made from new designs and new patterns are subject to X-ray examination to establish that the technique employed, i.e., method of molding, method of gating, etc., is satisfactory. The quality of castings after an acceptable procedure has been properly worked out has been found to be generally consistent. The condition is not particularly comparable to hand welding.

Mr. Davis asks why we have what he terms a more or less chaotic condition in the regulation of welding and answers, "because the public has been led to believe that welding is something mysterious that requires supervision of each welder and his work." I doubt that the public thinks there is anything mysterious about welding. They probably do think that it involves processes and practices with which they are not totally familiar and in which the experience and personal technique of the workman play an important part. If there is anything mysterious about welding it is the difficulty of judging by appearance the quality and efficiency of the welded joint. As Mr. Davis says "Welding requires a 'good' welder." Well, how are we going to determine a good welder? Certainly not by looking at him. Therefore, Mr. Davis has already set up a requirement for some type of qualification of operators. Mr. Davis wants to get the same acceptance for the work of a good welder that is given to a riveter or machinist. I am afraid this is fundamentally a wrong approach until the time comes when a tool as simple as a micrometer can be placed on a welded part and the exact quality of the welding can be determined.

I trust that Mr. Davis will not feel that I am unduly critical of the views set forth in his letter. We are simply looking at the subject of welding through different eyes. His company is in the business to sell more and more welding equipment and supplies. My direct interest in welding has been, in part, to see that the welding in high pressure, high temperature, operating equipment was of adequate quality to insure that there would be no possibility of failure.

Mr. Davis has, however, pointed a justly accusing finger at certain conditions existing today because of the overlap of assumed authority by various regulatory bodies, antiquated requirements in specifications and codes, and lack of uniformity of requirements by different agencies and bodies. This, I would not say, has come about because of the public believing that welding is mysterious. Rather has it come about because of the tendency of the times for governmental regulation and to the building up of agencies through federal, state, county and municipal control. It has possibly also come about through lack of adequate knowledge within the welding industry of means of controlling quality and methods of assuring that adequate quality has been obtained, together with the slow development of simple, clear requirements in the industry that could be substantiated as adequate to any agency or body developing and promulgating codes, regulations or specifications having to do with welding.

Mr. Davis' letter could well be the spark of initiative that would touch off a worth-while and comprehensive evaluation of the seriousness of conflicting codes and antiquated requirements. It is always well to first have an evaluation or a measure of the significance or seriousness of any situation which is so unsatisfactory that something must be done about it before any extensive program is launched to solve a problem the length, breadth and scope of which have not been examined.

Possibly the time has arrived when some organization, and there should be none better than the AMERICAN WELDING SOCIETY, should have a committee, or possibly a paid staff, to which all unduly restrictive requirements with respect to welding, all overlapping requirements by different agencies, and all antiquated specifications which contractors and suppliers are forced to meet are referred. This body would become a clearing house to see that those agencies which are concerned with codes, regulations and specifications are properly and forcefully advised of criticisms leveled against their requirements. Before setting up such an organization or committee, it might be well to take some measure of the scope of the difficulties by asking Mr. Davis and everyone concerned with welding to specifically recite definite instances of unneeded, unduly restrictive and conflicting requirements. If there should be a sufficient number of these instances to indicate that the welding industry is having a severe handicap imposed upon it, the WELDING SOCIETY would be remiss in not becoming active in the matter.

J. W. Wilson (*Senior Marine Engineer, U. S. Dept. of Commerce, Bur. of Marine Inspection and Navigation*):

I am heartily in favor of standardizing the rules for the qualification and requalification of welding operators along the lines proposed by the WELDING SOCIETY. I do not, however, believe it would be advisable, in the interest of welding, to waive the qualification rules, be-

cause to do so would let down the bars for a lot of inferior welding, which might have the effect of discrediting welding more than anything else that could happen.

I am also in favor of waiving the requirement for the submission of test plates for the annual requalification of welders employed in construction work, for the reason that the inspector in charge of supervision of welding has a continual check on the ability of the welder.

Regarding the statement in the fifth paragraph of Mr. Davis' letter—"good welder"—I know of no other means for proving the ability of the welder than the qualification tests.

Harry W. Pierce (*Supervisor of Welding, New York Shipbuilding Corporation*):

With reference to your letter of August 12th enclosing a copy of A. F. Davis' remarks regarding the qualification of welding processes and operators, my views have changed very little since some comments of mine were printed in the JOURNAL in September 1934. These remarks were about operator qualification; first, in that various inspection agencies and regulatory bodies insisted on their own particular type of test and, second, that nearly all required a periodic re-test.

In so far as marine work is concerned, a great deal of progress has been made in reducing the number and variety of operator qualifications. The Navy Department requires but one test, regardless of Bureau cognizance, which test is acceptable to a number of other government agencies. More remains to be done, however, for although we might have welders fully tested and qualified to weld any pressure vessel, fired or unfired, for use on naval vessels, such qualification is not recognized by the various insurance companies for work under the A. S. M. E. code. This recently placed us in the position of having a number of pressure vessels in production in our shop for a Navy contract, yet we were unable, without excessive loss of time as well as expense, to build two similar tanks for use in our own power house.

Recently, steps have been taken by the Navy Department to reduce or eliminate "re-tests" for men who are continuously employed. This is most certainly a logical step, for we have never discharged or disrated a welder because of inability to pass a periodic re-test. Nearly all major shipyards have qualification records extending back over ten years or more and I have found none who have ever uncovered an unsatisfactory operator by the periodic re-test. I am entirely in favor of a searching qualification test, made under standard conditions by a competent authority, before a man can weld on production work. I see no reason, however, why the various regulatory bodies cannot accept the certificates or records made for any one of them and eliminate re-testing except after long periods of idleness.

Process qualification and tests are of somewhat later origin than operator qualification. While it is true that many operations have become standardized in that we all follow almost identical procedure and methods, I do not believe that these tests can be eliminated. They can be sharply reduced since a single process approval test covers a certain combination of metal, shop equipment and procedure and should apply to the use of that combination regardless of application and customer. In this respect, the process approval test should be like the operator qualification test; if performed for one competent authority, it should be accepted by all others.

The actual number of operator qualification and process approval tests which are required to cover the industrial field of ferrous welding applications has been thoroughly surveyed by a committee of which Mr. Charles Jennings is chairman. The report of this committee, which is now, or will shortly be in your hands, will show the relatively few tests which are required to cover all commercial applications. The next step, as I see it, is to induce all code authorities to accept these tests when performed under the cognizance of any one of them.

Van Rensselaer P. Saxe (*Consulting Engineer*):

There has been too great an idea created that welding is a mysterious process and every welder treated as though he were a criminal to be watched, because one can have no confidence in what he does. On our work I have watched many welders and with few exceptions I would trust them to do their work properly without any inspection.

I feel that I am a conservative engineer, but I am not so conservative that I hide behind that cloak of respectability, to block progress on matters which as an engineer I should study and understand.

As I see the matter, not much else can be expected under the present set-up, with the older engineers and executives in control of the various groups. We will have to wait until the younger engineers develop into a position of prominence, for the older men have been brought up on rivets and it's hard to teach or get an old dog to learn new tricks. The younger man today is being taught about welding in school, so he is able to grasp the fundamentals of it, and to him it is no mystery. When these men get in the saddle, Mr. Davis' thought will come true and not until then.

Speaking of the older men, I write from experience, for I know how much personal time and effort I had to put into study and research because, years ago, one of my clients insisted on a welded job. Fortunately, I had an office so organized that I could do this without hurting my business time, so I built my first welded job. Unfortunately, a lot of engineers cannot afford time required or do not feel inclined to do such work, so they side-step or say welding is an "unknown," and should only be used under the most severe restriction.

Our office practice for the usual type of work we do has been to accept and use electrodes with which the welders are familiar and which have been process qualified, for the work to be done. We do not ask for requalifying for our work unless it is very special. We will accept any welder who can show that he has been properly qualified by any recognized authority, for the work to be done, provided he can give us assurance through reference to a previous employer, that he has done the type of work we expect done, within a time not exceeding three months. We further require that he start welding at unimportant points to get his hand in and give our inspector a chance to observe his first efforts. After a man has proved himself, our inspector's chief work is one of cooperation, to check with the welder proper positioning, size and length of weld required at all points in the structure.

This process quickly eliminates a poor welder and saves a lot of expense. We require qualification of a man who has no record. This costs about $25 here.

We have used with entire success the method outlined above, which seems about as simple a method as can be developed and might be in line with Mr. Davis' thought.

A. C. Weigel (*Combustion Engineering Company, Inc.*):

I carefully read Mr. Davis' letter and from what I can gather he objects very much to the new rules for procedure of operators and qualifications as drawn up. As to the fabricator doing a great deal of welding both in the shop and in the field, I realize that there is quite a lot of inconvenience and expense in following the procedure,

both as to qualification processes and classification of operators. However, I feel that welding done directly under the proper procedure and by proper men for which the manufacturer must of necessity be responsible, is safe, and that responsible experienced manufacturers have to go to what looks like very heavy expenses. However, improper welding, whether due to procedure or the operator, can be the source of unknown losses and troubles.

In the early days manufacturers of welding equipment and others led the user to believe that if they bought a good machine, that was all that was necessary to do proper welding. There are too many features involved and many times even what is known as good welding operators turn out inferior work. Welding, properly done, is the best type of construction. The more of it the merrier. I feel that we are going to have to pay the penalty until everybody learns that proper procedure and proper operators must be proved. There is still a great deal of educational work to be done and our Association has done a great deal toward removing the doubt of the value of welding, which was free of restrictions before regulations were set up. Do not think it advisable to do as suggested by Mr. Davis.

Closure

[*Editorial Note.—Mr. A. F. Davis was provided with an opportunity of seeing the comments on his editorial and invited to add any closing remarks. There follow the closing remarks by Mr. A. F. Davis.*]

It is evident from the comments made, that my previous communication was interpreted as meaning that I was opposed to all codes, qualifications, etc.

This is contrary to the facts. I am not opposed to all codes, regulations, qualifications, tests, etc., but I am opposed to:

(*a*) The fact that many codes are unduly restricted.
(*b*) The fact that many codes overlap and have overlapping authority.
(*c*) The fact that things which are permitted in one code are not permitted in other codes, even though the objects welded are frequently for similar purpose and subject to similar service requirements.
(*d*) The fact that one code or authority will not recognize the qualification or certification of a welder when he is qualified or certified under another code or authority, even though the work he is required to do is quite similar in character and quality.
(*e*) The fact that one code or authority will not recognize the qualification or approval of an electrode approved by another code or authority, even though the electrode may be used for a similar purpose or similar service requirement.

Anyone of the gentlemen who have commented on my previous letter could name dozens of conflicts such as I have mentioned.

If the above facts to which I am opposed could and would be corrected by the AMERICAN WELDING SOCIETY, the SOCIETY would be performing a great service to the users of welding, as well as to the manufacturers of welding equipment and electrodes. They would lessen the cost of welding to a very considerable extent and thus make this splendid tool of humanity of far wider value and utility.

Not only do we need uniform, simplified codes and qualification tests, but we need their adoption by all the various societies, authorities and governing bodies including Federal, State and City governments.

I know that this is a difficult job. I know that progress has been made by the SOCIETY in writing codes, etc., yet far more progress than this is necessary. I know that many in the SOCIETY will be opposed to pushing such a program, by the SOCIETY. I know that many will say that it is difficult or impossible of accomplishment.

The fact remains, however, that the points I have mentioned are a serious hindrance to welding and either the SOCIETY or someone, sooner or later, is going to take the steps necessary to bring about the correction of these evils.

Belgian Fatigue Tests of Defective Welds*

SINCE poor root fusion and slag inclusions were the only defects found by X-rays in a welded bridge, pulsation tension fatigue tests were made on the double V butt welds in Fig. 1. The open-hearth steel contained at most 0.15 C, 0.85 Mn, 0.04 Si, 0.04 P, 0.04 S and had: tensile strength = 60,000–78,000 lb./in.^{2}, yield strength = not less than 34,000 lb./in.^{2}, elongation = at least 20%, Charpy notch impact value = at least 6 mkg./cm.^{2} Weld metal from the covered electrodes had: yield strength = 43,000 lb./in.^{2}, tensile strength = 64,000–78,000 lb./in.^{2} (average = 68,000 lb./in.^{2}), elongation = at least 20%. Examination revealed that the plates were free from laminations.

The specimens for fatigue test were cut from sections that were found by X-rays to be defective. The welds were not machined and the tests were performed in an Amsler pulsator (110 tons capacity, frequency = 500 cycles per minute) with a lower tensile stress of 8500 lb./in.^{2} The upper stress was 17,000 lb./in.^{2}, which was the maximum for which the joint was designed. No cracks being found after 2 million cycles, the upper stress was raised to 20,000 lb./in.^{2} After an additional million cycles the stress again was raised to 23,000 lb./in.^{2} At this stress failure occurred in 111,900 cycles. Examination of the fracture showed that the crack started in the region of poor fusion at the root.

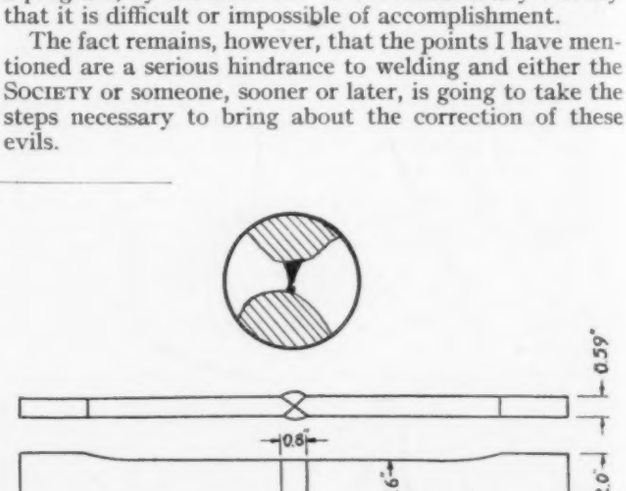


Fig. 1—Dimensions of Fatigue Specimen of Double Bevel Butt Weld
The incomplete root fusion in the welds is shown in the circle (traced from a macrograph)

* Extract from "Le Nouveau Pont sur la Meuse à Ougrée," by H. N. F. Santilman, Published in *Annales des Travaux Publics de Belgique*, 41 (1), 9–69 (1940).

Cost Estimating Formulas for Arc Welding

By Joseph V. Kielb*

IN ESTIMATING any welding design the following factors have to be considered: volume of welding, deposition rate, deposition efficiency, stub efficiency, over-all efficiency, cost of power per kilowatt hour, electrode cost per foot, labor cost per foot, volts and amperes, and operation factor. Summarizing these, there are three main factors; namely, labor cost per foot, power cost per foot, and electrode cost per foot, which will be combined in one common formula.

Estimators and draftsmen in industrial plants, shipbuilding, etc., should develop a greater knowledge of welding cost in order to have a more accurate cost figure when submitting bids for a particular job; the reason for this will become more obvious as competition increases. Today, many of the engineers of large and small companies are using data of welding cost secured from welding electrode companies. This information has been an aid to the small job shops and others, but many factors have been omitted from such data.

There has been some discussion that a more accurate and shorter method of figuring cost by a common formula is needed whereby all factors are considered and may be applied to arrive at a more accurate cost figure. This discussion is to reveal some advance data for a more accurate estimating cost on different types of joints. A common formula will be established for a given groove in order to simplify the calculation for different thicknesses of plate and opening of groove.

In standard type grooves, the use of standard formulas is established for the cross-section area of the welded groove, as illustrated in Fig. 1. The opening of groove and the thickness of any plate now may be applied to these formulas to determine the cross-section area of weld metal for a given groove. The reinforcement of the weld and the penetration in the backing strap and the side walls of the groove must be given some consideration in respect to the volume of deposit of weld metal. One may derive a standard formula for the cross-section area of any kind of groove other than that mentioned here by a similar method.

After one of these formulas has been applied to a definite welding procedure for a particular job, the following factors have to be considered in order to compute a more accurate total cost of weld metal per foot.

The weight of deposition per foot is calculated by multiplying the cross-section area by 12 inches and the weight of steel per cubic inch—0.284 lb. Deposition rate is the amount of electrode deposited in cubic inches per minute of arc time.

Deposition rates are determined in the following manner for the particular electrode to be used. The weight of the electrodes used minus the weight of stubs gives the weight of electrodes actually consumed. The weight of the deposited metal is then subtracted from the weight of electrodes to give the spatter loss, which consists of flux, core and stub losses. It will be noticed by observation and record that reverse polarity electrodes have greater spatter loss than straight polarity electrodes. Thus, the percentage of spatter loss is then determined. The rate of deposition per second will be the weight of metal deposited divided by the total welding time in seconds. Then the rate of deposition per second could be converted to the rate per hour by multiplying the results by 3600.

The following table has been compiled for the rate of deposition in pounds per hour of different grades and sizes of electrodes, organic and mineral, identified by A. S. T. M. and A. W. S. specifications. In Class I (the all position electrodes) the rate of deposition in flat, vertical, horizontal and overhead positions will be approximately equal; the flat welding positions maintaining the slightly higher deposits, due to less spatter losses. Class II electrodes are used only in flat, downhand, and horizontal fillets.

Size, In.	Classes I	II
1/8	1.56 lb./hr.	1.56 lb./hr.
5/32	2.19 lb./hr.	2.50 lb./hr.
3/16	3.12 lb./hr.	3.75 lb./hr.
1/4*	4.75 lb./hr.	5.10 lb./hr.
5/16	...	7.30 lb./hr.

*Flat and horizontal fillets only.

Finally, the deposition efficiency is found by the ratio of the deposited weight of metal to the weight of electrodes consumed. The minimum average deposition efficiencies of electrodes, sizes 1/8 inch to 5/16 inch, is 55 to 65 per cent, identified by the above specifications. If a closer check on cost is desired, tests may be made with the electrode specified for a particular job to obtain the ratio of the deposited weight to the weight of the electrodes consumed. The difference will be very small and, therefore, have little effect on the total cost. Another way of securing the deposition efficiency is by subtracting the percentage of spatter loss from 100%.

From the following data on deposition rate, the stub efficiency is ascertained. The stub shall be 2 inches average length from every 14- and 18-inch electrode. The stub efficiency factor shall be 85.7 and 88.9 per cent, respectively. Then the over-all efficiency is found by multiplying the deposition efficiency by the stub efficiency.

The operation factor affects the speed of welding, labor cost and power cost. The operation factor is the ratio of actual arc time to the total pay time. The operation factor has a wide range, from 25 to 35 per cent or greater, depending upon the design of structure and

* Chief Instructor, Hemphill Schools, Inc., Long Island City, N. Y.

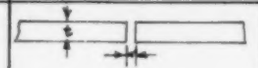
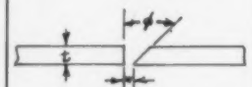
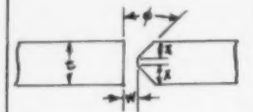
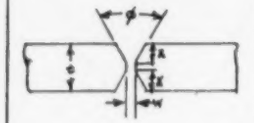
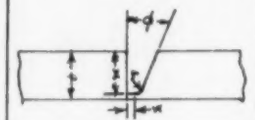
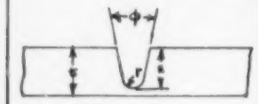
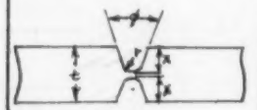
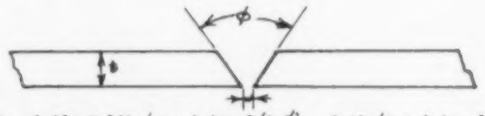
TYPE OF JOINT	DIAGRAM	AREA
Open Square Butt Groove		wt
Single Bevel Butt Groove		$t(w + 1/2t \tan \phi)$
Single V Butt Groove		$t(w + t \tan 1/2 \phi)$
Double Bevel Butt Groove		$wt + X^2 \tan \phi)$
Double V Butt Groove		$wt + 2X^2 \tan 1/2\phi$
Single J Butt Groove		$(w+r)(x-r) + \frac{\pi r^2}{4} + wr + 1/2\,(x-r)^2 \tan\phi$
Single U Butt Groove		$2xr - 2r^2 + \frac{\pi r^2}{2} + (x-r^2) \tan 1/2\,\phi$
Double U Butt Groove		$2\left[2xr - 2r^2 + \frac{\pi r^2}{2} + (x-r)^2 \tan 1/2\,\phi\right]$

Fig. 1—Cross-Section Area Formulas

SINGLE V BUTT GROOVE



Area = $t\,(w + t \tan 1/2\,\phi)$

Weight of deposition per foot = $0.284 \times 12t\,(w + t \tan 1/2\,\phi) = 3.4t\,(w + t \tan 1/2\,\phi)$

Deposition Rate = (R) — Volts Required = (V)

Deposition Efficiency = (E) — Amperes Required = (A)

Stub Efficiency = (S) — Power Cost per K.W.H. = (P)

Overall Efficiency = (O) — Electrode Cost per lb. = (C)

Operation Factor = (F) — Labor Cost per hour = (L)

$$\text{Speed of Welding per foot per hour} = \frac{(R)(F)}{3.4t\,(w + t \tan 1/2\,\phi)}$$

$$\text{Weight of Electrodes used per foot} = \frac{3.4t\,(w + t \tan 1/2\,\phi)}{O} \qquad \text{Note: } O = (E)(S)$$

$$\text{Power used per foot} = \frac{(R)(F)}{3.4t\,(w + t \tan 1/2\,\phi)} \div \frac{(V)(A)}{1000} = \frac{3.4t\,(w + t \tan 1/2\phi)\,(V)(A)}{1000\,(R)(F)}$$

1. Labor cost per foot $= \frac{(L)\,3.4t\,(w + t \tan 1/2\,\phi)}{(R)(F)}$

2. Power cost per foot $= \frac{3.4t\,(w + t \tan 1/2\,\phi)\,(F)(V)(A)}{1000\,(R)(F)}$

3. Electrode cost per foot $= \frac{(C)\,3.4t\,(w + t \tan 1/2\,\phi)}{O}$

$$\text{TOTAL COST per FOOT} = \frac{(L)\,3.4t\,(w + t \tan 1/2\,\phi)}{(R)(F)} + \frac{3.4t\,(w + t \tan 1/2\,\phi)\,(F)(V)(A)}{1000\,(R)(F)} + \frac{(C)\,3.4t\,(w + t \tan 1/2\,\phi)}{O}$$

$$\text{TOTAL COST per FOOT} = 3.4t\,(w + t \tan 1/2\,\phi)\left[\frac{L}{(R)(F)} + \frac{(F)(V)(A)}{1000\,(R)(F)} + \frac{(C)}{(O)}\right]$$

Fig. 2—Illustration of Common Cost Formula for Single V Butt Groove

working conditions. In production welding, this factor is probably considered higher. In determining labor cost one must consider every person involved in the completion of a welded joint—the welder, his helper, foreman, engineer—and the contractor's general overhead cost. All these items will tend to bring the labor cost per hour very high. The speed of welding will vary according to the size of electrode and the position of welding. Usually the speed of welding will be greater in shop welding than in field welding due to the fact that shop welding is generally performed downhand or in the flat position, while field welding may combine flat, vertical and overhead positions. Also the size of electrode used in the field is generally smaller because it is easier to handle. Therefore, the cost of shop welding will be less than field welding. Regarding power cost, it is known that welding motor-generators are more stable than the gas engine generator sets. The former is used mostly in shop welding while the latter is used in field welding.

The cost of power per kilowatt hour (P) multiplied by the weight of deposition per foot, times volts (V), times amperes (A), and then divided by the deposition rate (R), 1000, and operation factor (F) will determine the total cost of power per foot of weld; simplified by formula

$$\text{Power cost per foot} = \frac{(P)(V)(A)(\text{weight of deposition per ft.})}{1000(R)(F)}$$

One must consider the consumed power while the electrode is not in operation in order to turn over the generator in an idling stage. This consumption of power varies from $^1/_4$ to $^3/_8$ of the actual arc power used. In transformer equipment this condition does not exist.

The cost of electrodes per foot is determined by the weight of deposited metal per foot multiplied by the cost of electrodes per pound divided by the over-all efficiency. This cost of electrodes will vary with every job, usually depending on the size of electrode to be used and the position of welding.

Combining the factors just discussed, one can now develop a common cost formula for the individual groove in any welding position. The thickness of plate and the opening of groove may vary, but this variation does not affect either the cross-section area or the total cost formulas. The values have only to be substituted into the common equations. In Fig. 2, the formulas are illustrated in terms of symbols. Thus, the cross-section area, of the weight deposited per foot and the total cost per foot, may be determined.

In fillet welding cost, the required cross-section area would be that of an isosceles right triangle or $X^2/2$. This factor multiplied by 12 inches and 0.284, the weight of steel per cubic inch, will give the weight of deposition per foot of a fillet weld—1.704 x^2. In making a fillet weld, the amount of weaving is much less than in butt grooves. The size of fillet in respect to the plate thickness has usually been too large. It has been revealed that fillet sizes could be reduced to a size where the fillet is one-half the thickness of plate to be welded. Fillet welds of required size would require a definite number of fillet passes, depending upon size of electrode used and position of welding. It will be observed that overhead fillets require more passes, while the horizontal is next and vertical last. The maximum diameter electrode used in vertical and overhead position is $^3/_{16}$ inch, while in horizontal fillets $^1/_4$-inch electrodes are used plus the aid of passes with smaller diameter electrodes. To the present date, the control of fillet sizes has been in the hands of individual companies using welding.

Discussion—"Welding in Shipbuilding"*

By E. B. Williams†

The AMERICAN WELDING SOCIETY, the Society of Naval Architects and Marine Engineers and the entire shipbuilding industry throughout the country are greatly indebted to Mr. Arnott and to the American Bureau of Shipping of which he is Vice-President and Chief Surveyor. Both societies have had valuable contributions to their annals by Mr. Arnott and the paper he has just given is outstanding. It is well, at times, to stand back from the details of welded construction and look at our work perspectively, so that we may see how far we have come, where we stand today and perhaps a little of what the future may hold.

Welding was applied with great caution in the shipbuilding industry and rightfully so. The failure of a single part of the ship's structure could easily cause a total loss, endangering the lives of all on board. Until recently there was no welding in any of the principal members, and now, as is seen in the table in the paper, there has been an almost complete turnover.

It has not been an easy task to bring this about. In fact, were it not for the American Bureau of Shipping, Mr. Arnott's table might have been in reverse. The ship owners and shipbuilders both recognized the advantages offered by welding, but could not realize them without the approval of the classification society. The American Bureau stepped in and soon became ardent supporters of welded ship construction. Not only were they willing to consider the substitution of welding for riveting, but they encouraged designers to use more welding and to redesign their structures, getting away from rivets entirely, thus entering a new sphere.

Such courage and foresight should be publicly recognized, which is the main object of this discussion. Welding in shipbuilding brings up new and difficult problems of design and construction and the industry is indeed fortunate to have a classification society such as the American Bureau of Shipping.

* Paper presented by David Arnott and published in THE WELDING JOURNAL, Nov. 1940.

† Naval Architect, The American Ship Building Co., Cleveland, Ohio.

Discussion—"Spot Welding in Aircraft Construction"*

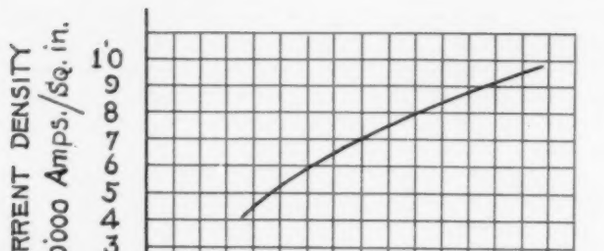
By C. W. Steward†

Mr. Marschner has presented an excellent survey of the requirements for spot-welding equipment suitable for aircraft work. It should be especially helpful to those who are contemplating the purchase of new equipment.

The major part of this paper covers data and experi-

* Paper presented by Charles F. Marschner and published in THE WELDING JOURNAL, October 1940.

† Welding Engineer, Westinghouse Elec. & Mfg. Co., E. Springfield, Mass.



Limiting Value of Current Density for Welds in Silicon Brass with High Conductivity Points

ence which, to my knowledge, are correctly and well presented and, therefore, do not require discussion. I would, however, like to make a few comments regarding the four recommendations given at the close of the paper. The numbers below refer to the corresponding recommendation in the paper.

1. This statement is not quite clear. Mr. Marschner doubtless refers to the past custom of rating welding machines in terms of kva. which has little value in indicating the capacity for a machine to weld a particular job. It is my understanding that this condition is well on the way toward being cleared up by an agreement among the members of the Resistance Welder Manufacturers' Association to rate all new equipment in terms of maximum secondary amperes and impedance. Perhaps Mr. Marschner had in mind the need for all data published on welding set-ups to be given in terms of secondary amperes instead of kva., thus making it possible for others to compare results and add to their own records.

I doubt whether it is necessary to establish a standard instrument for measuring actual output amperage throughout the range. The important thing is for the method of calibration to be acceptable for the accuracy desired. It might be desirable to establish a degree of accuracy for such calibration such as "Calibration of secondary amperage shall be accurate to $\pm 1\%$ at specified primary voltage." I have found the pick-up coil referred to is a very simple and satisfactory device. It has the advantage over many other methods that it can be used for taking readings while actually making a weld.

2. There is ample room for research work of a practical nature on the subject of amperage, pressure, timing, tip shape and diameter as suggested by Mr. Marschner. I have a belief at the present time that there is a rather definite relation between current density and unit pressure for a sound weld. I also believe that some work should be done on the matter of determining the minimum unit pressure *vs.* thickness of stock, which will prevent formation of gas pockets in a given material. I expect this will be different for different materials. It may be possible to establish a practical minimum value for all materials.

Some work has been done on establishing the minimum timing *vs.* thickness for certain materials (*cf. Aviation*, September 1936 and THE WELDING JOURNAL, 17, Nov. 1938, Research Supplement, pp. 45–54) but this is a subject which needs to be studied further to cover other material besides aluminum.

Standardization of settings would seem rather difficult to accomplish. It certainly is not practical unless the surface condition, or treatment, is carefully standardized also. For purposes of comparing results or for qualification of equipment some such standard surface condition is not only desirable, but necessary.

After all, for production work, the problem is not so much the kind of surface treatment as it is the uniformity of surface, so that once a satisfactory weld is produced it can be duplicated day after day.

3. It seems to me that for purposes of comparison, standardization or design, the matter of design strength always reverts back to maximum strength for sound welds. If an allowable strength is established there is always the question of how much margin exists, so I believe any standards should be based on maximum strength and sound welds. If the equipment or an operator is being qualified we are interested primarily in how strong a weld can be produced and still be sound. The matter of allowable values is something to be determined to suit the design or operating conditions.

Considerable work has been done by the Navy and the Army toward the standardization of test specimens and methods of test as well as qualification tests for operators and equipment. Some of the Navy requirements for tests during production are a bit too drastic to be practical in this day of speeding up defense, but at least, a start has been made.

4. Inspection of welds is a subject which needs a great deal of consideration. To my knowledge there is no non-destructive method of inspecting the quality or strength of spot welds which is practical for production work. All methods so far are purely laboratory type tests. As soon as an absolutely reliable and rapid method of examining production welds is developed there should be a tremendous increase in the use of spot welding.

Discussion—"Design and Construction of Arc-Welded Steel Structures*

By T. R. Higgins†

The author has given us an excellent picture of the problems involved in the application of welding to the design and construction of steel structures. That progress has been made in the solution of these problems must be apparent to all who have witnessed the developments of the past ten or fifteen years. At times, particularly in the early stages, the progress must have seemed discouraging. Many practices, that at first offered promise, have since given way to improved techniques and it is probably safe to predict that this process, even now, has not entirely run its course.

Yet out of these experiences a sound working knowledge has grown so that it is possible today to list many rules and practices which make for efficient execution of welded construction within the framework of the existing organizations which, collectively, are responsible for the design, fabrication and erection of steel structures.

As the author has pointed out, the adoption of welding in place of riveting in this industry has been relatively slow as compared with developments in other metal-working industries. He has cited the factors which have

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* Paper presented by LaMotte Grover and published in THE WELDING JOURNAL, Oct. 1940.

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retarded a more rapid evolution. A closer examination of these factors suggests certain other fundamentals, recognition of which should assist in its development.

In the first place attendant economies, resulting from the use of welding in ordinary steel construction, have been nowhere near as striking as in other steel-fabricating industries. In many classes of structural work the margin has been insufficient to provide a buffer to care for the inevitable expense contingent with any major change in a manufacturing process. This fact, frankly acknowledged, suggests two policies which, in the long run, should promote the widest application of welding in steel construction.

Just as it is considered sound judgment to field bolt shop-welded structures, where field bolts are permitted, in order to attain the lowest over-all cost, so should the economics of shop fabrication be carefully examined, as between welded and riveted work, to arrive at the lowest over-all shop cost.

This is not to advocate that both techniques should necessarily be employed in the fabrication of a single shipping piece. It is seldom that they should be. But, with facilities for both kinds of work available, as is the case in most plants where welding is done today, an intelligent division of the work in the drafting room stage can frequently be made to show greater economies than would be possible under rigid requirements either for all-welded or all-riveted fabrication. Latitude should be given the fabricator to choose when proper execution of the design is not effected. Enthusiasts for welding, who regard the introduction of a single rivet as a blight on the fair name of a so-called "all-welded" job, do the industry no service in insisting on averaging welding economies, where real savings are possible, with doubtful economies, or actually higher costs, on the balance of the shop work.

The high degree of organization and standardization of practices, which the author has mentioned as existing in the structural steel fabricating industry, are neither whimsical nor arbitrary. Nor are they a blind devotion to mere tradition. They are the product of forty years or more experience resulting from countless economic studies, and under the strong competitive forces within the industry, they are static only to the degree that they continue to produce results. But under them has been made possible something approaching mass line production in the manufacture of a decidedly custom-built commodity.

A similar standardization of practice, looking toward efficient organization, requiring a minimum of expensive direct technical supervision, would seem to be a very desirable goal in the fabrication of welded structural steel. As has been pointed out, some progress has been made in this direction. There is room for a great deal more.

As fundamental research and engineering thinking evolve new welding developments they must be tested for their economic significance and only after such a test can they become a part of a standard practice worthy of such a name. Only then should they be advocated to displace, as standard practice, an earlier welding technique.

In recent years, in this country, we have felt the impact of the application of welding in steel construction as developed in European countries. Interest has been further stimulated by experiences in allied industries in this country where the employment of welding has produced economies of sufficient importance as to suggest entire abandonment of previous production methods and a complete reorganization of personnel and equipment to capitalize at once the fullest advantages welding can offer. Before applying the practices in welded design, suggested by these two sources, to the design of steel structures here these practices must be tested for their potential economies in terms of the skills, and organization based upon these skills, existing in the structural steel fabricating industry in this country today.

In the case of the European practice, difference in the ratios of labor costs to material costs, here and abroad, must not be lost sight of. In drawing upon the experience in allied industries for welding practice we must bear in mind that the narrower margin of possible savings in the structural fabricating industry does not offer the same incentive, as in these industries, for a complete reorganization.

Thus, for example, an excessive use of butt welds with relatively expensive edge preparation and assembly devices, even in shops equipped, manned and trained for the necessary controls in close tolerances, may make a disappointing showing on the cost sheet. Fabricators of structural steel have been accustomed to work with close tolerances—as close as those required in butt welding—but the controls have been largely directed toward the location of rivet holes, the accuracy of which is commonly assured by the use of inexpensive wood or cardboard templates. Shop standards provide ample clearances at the edges so that little attention is required in their preparation for assembly. When these edges become the control points—as is the case with butt welds—not only is the cost of their preparation increased but new problems arise in assembling the parts to be joined.

If there is sufficient duplication to warrant the investment, special jigs can be made to assist in the fitting-up, provided the assembly is not too large. But even where jigs are designed for diverse application it is surprising how quickly an accumulation of such devices can pile up to dismay the fabricator who is reminded that his riveted assemblies seldom require such auxiliary equipment.

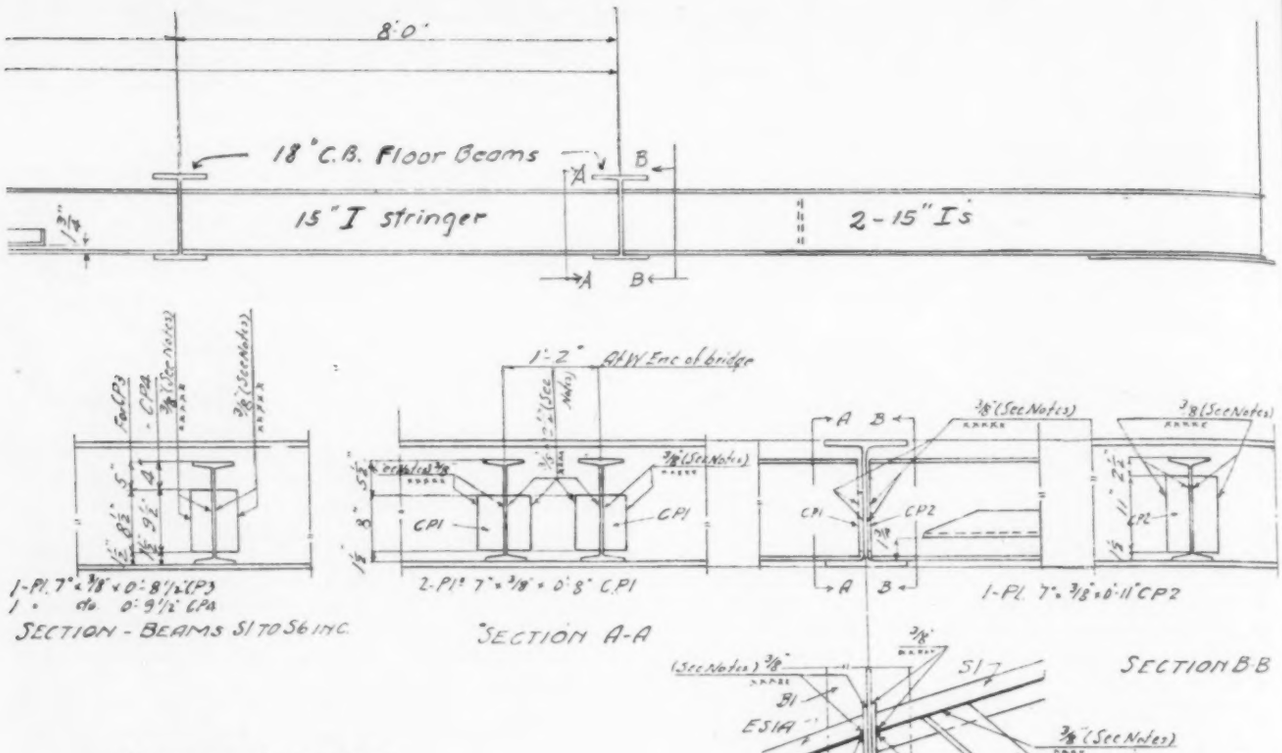
Except where unquestioned savings can be predicted for a design which involves new and untried assembly problems, such designs should be avoided. The use of fillet welds, not requiring special edge preparation, and the principle of lapping parts to be joined so that simple equipment of universal adaptability, such as clamps, will suffice in the assembly, can still be cited as a fundamental offering, in most cases, a maximum over-all economy—even at the expense of a little added material. At the present time at least 75% of the welds employed in the fabrication of steel structures are of the fillet type.

The welding literature is replete with references to shrinkage stresses and the distortion resulting from the cooling of welds. It is frequently prescribed that the designer shall make proper provision for these phenomena in the execution of his design. Yet so little of a tangible nature has been published that, after studying it all, the designer is left with a sense of his inadequacy in the discharge of this responsibility. His fears may be twofold. The first has to do with the safety of the design; the second concerns unanticipated costs required to control or correct distortion.

A better understanding of the properties and behavior of mild structural steel in the plastic range, cited by the author and long known to physicists but seldom reckoned with in engineering design, would do much to dispel the first bugaboo, at least where fatigue is not a factor.

The problem of distortion is largely the responsibility of the fabricator—to be solved by him in the execution of his work. In this connection it would seem that the widest possible exchange of experiences in handling this problem would be most beneficial to all.

The suggestion that the engineer designing the struc-



WELDING AT JUNCTION OF BEAMS B1, S1, ES1
Details shown are typical for welding, etc. for all stringers to floor beams

Fig. 1

ture can contribute much to minimize this problem is largely specious. The author, in his list of fundamentals of design, has very well covered the points in which the designing engineer can assist. The suggestion, however, that he visualize all construction operations for the purpose of controlling distortion and shrinkage stresses carries little significance except where he may also prepare the shop drawings of the parts to be fabricated.

But, since so much of the knowledge regarding distortion can only be acquired in the actual fabrication and since the cost studies necessary to an economical design of the connections must be based on actual shop experience, it would seem advisable that as much latitude be left to the fabricator as possible in the working out of the details. Except in so far as the matter of strength requires detailed amplification on the design drawings, the shop drawings should be prepared by the fabricator or a consultant closely in touch and in harmony with the fabricator.

Such a procedure suggests the necessity for placing wide confidence in the ability and integrity of the fabricator. But it was upon exactly this same basis of confidence, which permitted the widest latitude for the expression of individual intelligence and ingenuity, that the standard practices in rivited fabrication were evolved.

Discussion—By A. W. Carpenter*

It might be of some interest in the flexible connection problem to show a detail we worked out for stringer-to-floorbeam connections for a small weld-connected bridge that we built on an industrial track recently. The stringers are skewed with the floor beams, making the use of square-angle connections impossible and bent plates would have been expensive and not very satisfactory. We worked out the problem by putting a plate on each floor beam web, fillet welded on sides only and then fillet welding the ends of the stringer webs to these plates. The webs of the stringers were cut on the skew of the beams to fit closely. The plates were mostly placed for connection of the stringers on the lower portions of their webs.

The plates, without connection to the floor beams on their top edges, afford some flexibility there, as is the case with riveted connection angles. Whether or not water will get in back of the plates and corrosion take place is a question. The floor beam top flanges afford doubtful protection against this action.

Figure 1 illustrates part of the plan for the bridge that shows the connection detail.

* Bridge Engineer, The New York Central Railroad Company.

Investigation of Welding for Naval Piping*

By Bela Ronay†

PIPE welding for the Naval Service must and does receive a most serious consideration.

Failure of a welded pipe joint carrying high-temperature, high-pressure steam occurring aboard a combatant vessel may have far more serious consequences than a similar defect in an industrial power plant.

The piping aboard a naval vessel comprises both low- and high-pressure lines. Accordingly the investigation concerned two separate problems; namely, the welding of thin-wall tubing for low-pressure service and the welding of heavy-wall tubes for the high-pressure lines. In each type the welding of tubes of 2-inch I.P.S. and smaller was regarded as a problem requiring individual treatment in so far that both the joint design and the technique applicable to the welding of small diameter tubes differ from those suitable for joining tubes of larger diameter.

In view of the above, the investigation was delineated to cover the following major problems:

1. Welding of thin-wall tubing of 2-inch I.P.S. and smaller.
2. Welding of thin-wall tubing of $2^1/_2$-inch I.P.S. and larger.
3. Welding of thick-wall tubing of 2-inch I.P.S. and smaller.
4. Welding of thick-wall tubing of $2^1/_2$-inch I.P.S. and larger.

Welding of Thin-Wall Tubing of 2-Inch I.P.S. and Smaller

The investigation covering the welding of small diameter, thin-wall tubing was performed with the view in mind of furnishing information concerning the following points:

(*a*) Applicable joint design.
(*b*) Applicable methods of welding.
(*c*) Minimum wall thickness permissible for each applicable method of welding.
(*d*) Minimum allowable clearances in position work for each applicable welding method.

The joint designs considered in the course of the investigation are shown in Fig. 1. In all, five designs were investigated, namely:

(1) Square-butt or saddle-weld type.
(2) The Detroit Edison type in its original form.
(3) A modified or simplified form of the above.
(4) A streamlined insert, identified as the Bureau of Ships design.
(5) Two types of external sleeves.

The material used in connection with the evaluation of the above-given designs was $1^1/_4$-inch O.D.—0.109-inch wall thickness seamless, medium steel tubing. The electrodes were $^3/_{32}$ inch and $^1/_8$ inch diameter Class I, Grade EA material.

Welded joints representing the above-given designs were produced in quadruplicate. Two joints for each design were welded in the fixed horizontal and two in the fixed vertical. In addition each design except the square-butt type which was found unsuitable because of the well-nigh unavoidable breaking through which resulted in icicle formation, was represented by another joint produced in the fixed horizontal. The latter joints were tested hydrostatically at 900 to 1200 psi using kerosene oil as the test fluid. All having been found pressure-tight, they were tested in static tension and all failed in base metal outside of the weld.

As all power piping and especially that installed aboard naval vessels is regarded as dynamically loaded structures, it was obvious that the suitability of the several types of joints produced cannot be fully evaluated on the basis of static tests.

Therefore, a dynamic test was applied which stressed the welded joints as freely suspended centrally loaded rotating beams installed with the weld at the center of the span. Figures 2 and 3 show the preparation of the specimens for dynamic loading and the method of installation, respectively. Figure 4 shows a battery of four machines designed for this purpose. The welding of the specimens designated for use in dynamic testing was recorded by Arcronograms and the welds produced were arbitrarily rated on the basis of the records in regard to their relative soundness. Thus the results obtained in dynamic testing could be further analyzed in regard to the joint design as distinguished from the effects of lack of soundness of the individual joints.

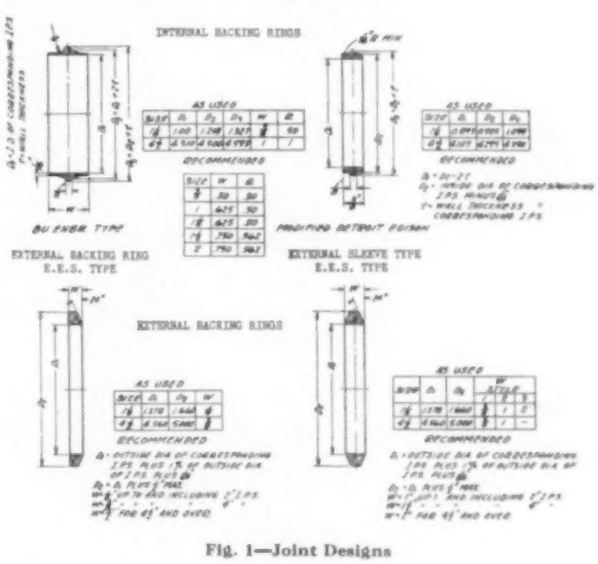


Fig. 1—Joint Designs

* Presented at the Annual Meeting, A. W. S., Cleveland, Ohio, Oct. 21 to 25, 1940. This paper represents only the personal opinions of the author and in no way reflects the official attitude of the U. S. Navy.

† Senior Welding Engineer, U. S. Naval Engineering Experiment Station, Annapolis, Md.

The results of the dynamic test are shown in Tables 1 to 6 and the summary of the test is given in Table 7.

According to the results given in the last-mentioned tabulation the endurance value of the external sleeve joints of 1-inch and 2-inch lengths was found to be the highest, being about 63% of that of the unwelded tube.

Later tests which were performed introducing certain refinements into the apparatus showed that the above-given values were lower than the true averages, and that they were lowered by the presence of stresses which acted upon the assemblies superimposed on those caused by the actual loading.

The results of the test further showed that stress relieving of these joints did not materially improve their performance; however, a better consistency was noted for the stress-relieved specimens. The effect of the joint design upon resistance to flow was determined for the types of specimens given above in connection with dynamic testing.

The method used for the determination of the flow resistance is indicated in Fig. 5. Figure 6 shows the bisected specimens used in connection with the flow-resistance test which included unwelded tube sections as a basis of comparison.

The results of this test are given in Table 8. According to this tabulation the external sleeves show the best performance for assemblies in which the tube ends are square and are in tight faying. The resistance offered by the streamlined insert is more than five times that given for the external sleeves and the conventional backing rings offer 10 to over 16 times greater resist-

Fig. 2—Method of Preparing Welded Assembly for Test

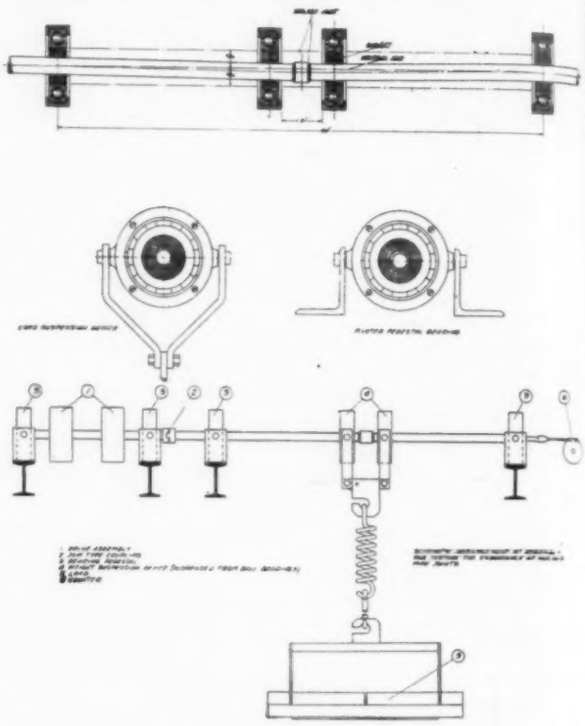


Fig. 3—Method of Installation

Table 1—Bureau of Engineering Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Max. Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Max. Psi	Tested Stress Relieved No. of Cycles
115	79	*A*	10,250	422,700	139	85	*A*	11,700	569,000
116	88.5	*A & B*	10,250	1,368,200	140	87	*A*	12,700	528,000
117	100	*C & B*	10,250	1,588,500	141	95	*A & B*	11,000	735,000
118	95	*C & B*	10,250	708,200	142	80	*A & B*	10,250	848,000
		Fatigue strength, psi	10,000				Fatigue strength, psi	10,000	

A—Fusion zone. *C*—Base metal.
B—Weld metal.

Table 2—Modified Detroit-Edison Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Max. Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Max. Psi	Tested Stress Relieved No. of Cycles
119	90	*A & B*	12,700	884,700	143	..	*A & B*	12,100	1,304,800
120	93	*B*	12,700	451,700	144	..	*A & B*	12,700	1,780,700
121	..	*B*	10,250	1,358,500	145	90	*	11,000	2,404,800
122	..	*A*	10,250	1,700,300	146	82	*	11,700	7,218,400
		Fatigue strength, psi	10,000				Fatigue strength, psi	11,500	

A—Fusion zone.
B—Weld metal. *Specimen removed before failure.

Table 3—EES External Sleeve Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Stress Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Stress Psi	Tested Stress Relieved No. of Cycles
123	....	*B*	12,700	376,100	147	75–90	*	11,700	1,938,700
124	75–80	*B*	10,250	748,400	148	82–88	*	11,000	2,826,600
125	72–90	*B*	10,250	771,600	149	82–90	*	11,000	2,000,200
126	83–..	*B*	10,250	506,300	150	65–77	*B*	12,100	1,060,800
		Fatigue strength, psi	9,000				Fatigue strength, psi	11,700	

B—Weld metal. *Specimen removed before failure.

Table 4—⅜ Inch Long External Sleeve Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Stress Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Stress Psi	Tested Stress Relieved No. of Cycles
127	....	*B*	12,700	1,788,700	151	95–90	*	12,700	1,978,100
128	..–100	*C*	12,700	998,000	152	92–90	*C*	12,700	1,145,900
129	80–100	*C*	12,700	434,400	153	85–95	*	12,100	2,188,300
130	80–100	*	11,700	1,979,900	154	85–95	*C*	13,900	1,021,000
	Fatigue stress, psi		12,000			Fatigue stress, psi		12,500	

B—Weld metal. *C*—Base metal.
*Specimen removed before failure.

Table 5—1 Inch Long External Sleeve Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Stress Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Stress Psi	Tested Stress Relieved No. of Cycles
159	85–95	*C*	13,900	1,704,800	162	95–70	*C & A*	14,100	1,255,700
160	85–95	*C*	13,500	1,642,700	163	100–95	*	13,900	4,772,300
161	95–90	*	13,500	1,684,400					
	Fatigue strength, psi		13,500			Fatigue strength, psi		13,900	

A—Fusion zone. *C*—Base metal.
*Specimen removed before failure.

Table 6—2 Inch Long External Sleeve Type Specimens

Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested As-Welded Stress Psi	Tested As-Welded No. of Cycles	Spec. No. ASX	Arcronograph Rating, %	Location of Failure	Tested Stress Relieved Stress Psi	Tested Stress Relieved No. of Cycles
135	88–88	*	12,700	3,651,100	155	..–80	*	13,900	5,178,400
136	92–79	*C & A*	13,900	461,100	156	85–85	*	13,500	5,588,100
137	93–93	*B*	17,200	174,700	157	80–85	*C*	13,900	1,050,000
138	....	*	13,500	1,990,700	158	90–98	*	13,500	5,077,800
	Fatigue strength, psi		13,500			Fatigue strength, psi		13,500	

A—Fusion zone. *C*—Base metal.
B—Weld metal. *Specimen removed before failure.

ance than the external sleeves. While the resistance of even the poorest performer is not alarmingly high for the individual joint, it is of serious consideration in an installation where a large number of joints are contemplated.

Examination of the four types of joints investigated reveals the following individual characteristics:

Bureau of Ships Type Joint.—The advantages of this type of joint are the small weight increase and the low flow resistance.

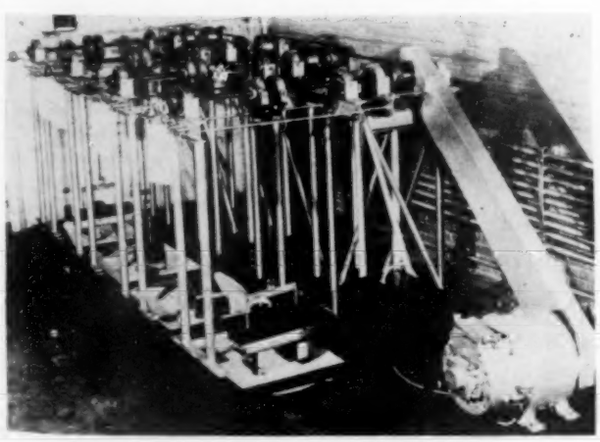


Fig. 4—Battery of Testing Machines

Table 7—Summary of Tables 1 to 6

Type of Joint Tested	Fatigue Strength, Psi As-Welded	Fatigue Strength, Psi Stress Relieved	Remarks
Bureau of Engineering	10,000	10,000	
Modified Detroit-Edison	10,000	11,500	
EES external sleeve	9,000	11,700	See Arcronograph ratings of "as-welded" specimens
⅜ in. long external sleeve	12,000	12,500	
1 in. long external sleeve	13,500	14,000	
2 in. long external sleeve	13,500	13,500	
Unwelded tube	21,300		Average value determined from three specimens

Table 8

Type of Joint	Equivalent Length of Straight Pipe, Feet
EES external sleeve	0.34
External sleeve	0.38
Bureau of Engineering	1.86
Modified Detroit-Edison	3.20
Detroit-Edison	5.97

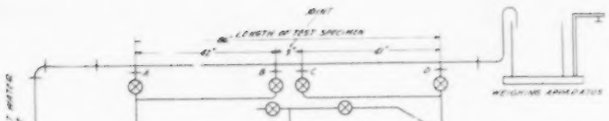


Fig. 5—Method of Determining Flow Resistance

The disadvantages are:

(*a*) The relatively high cost of the inserts.
(*b*) The additional labor required to expand the tube ends.
(*c*) The possibility of assembling the joint without obtaining the desired streamline effect through poor preparation of the tube ends.

External Sleeve Type Joints.—The advantages of this type of joint design are the low flow resistance and the ease of assembling.

The disadvantages are the added weight per joint and the possibility of increasing the flow resistance by careless assembling, leaving a gap between the tube ends.

Conventional Internal Backing Rings.—The advantages of this type of joint are the ease of assembly and the low weight per unit.

The disadvantage is the relatively high flow resistance.

In connection with the welding tests pertaining to tubes of $2^1/_2$-inch I.P.S. and larger, the material used was 4-inch I.P.S.—0.095-inch wall thickness medium steel tubing.

Assemblies were produced using the four basic designs given for the small diameter tubing.

On completion of the above-given series of tests, they were duplicated using the oxyacetylene method of welding.

The results of the latter test led to the following conclusions:

(*a*) Square-butt joints, especially those produced in the fixed vertical, do not possess an average of 100% joint efficiency.

(*b*) The distribution of the weld metal in the conventional internal backing ring type joints is not always satisfactory.

(*c*) The oxyacetylene method produces the most satisfactory joints when used in connection with the external sleeves in all positions.

(*d*) The endurance value for the oxyacetylene welded joints was found to be higher than for corresponding joints produced by arc welding. However, the better results obtained were partly attributed to the use of somewhat heavier tubes than were those employed in arc welding and to the refinements made in the design of the fatigue-testing apparatus by lessening the whipping and by generally improving the alignment of the specimens whereby stresses produced were more closely confined to those developing solely from the applied load.

It was found that the cost of the joints welded by the oxyacetylene method generally exceeded that for arc welding. However, for the small-diameter tubes especially it was found that regardless of the economic considerations, the quality and the appearance of the oxyacetylene welded joints were more uniformly satisfactory.

This is obvious in view of the fact that the oxyacetylene method being slower than arc welding offers a better opportunity to control the volume and the contour of the deposit.

The principal disadvantage of the oxyacetylene method for welding thin-wall tubing is found in the possibility of over-heating the base metal, and thereby causing undue grain growth beyond the fusion zone which tends to embrittle the joint.

The investigation showed that by means of electric arc welding sound welds can be produced using the sleeve-type assembly with tubes of 0.0625-inch wall thickness. In welding these thin-wall tubes a special procedure has to be observed, especially in connection with starting the arc and in finishing the increment.

The final decision of the Navy Department restricted the use of arc welding to tubes having a wall thickness in excess of 0.095-inch.

In course of the test it was found that the thinness of

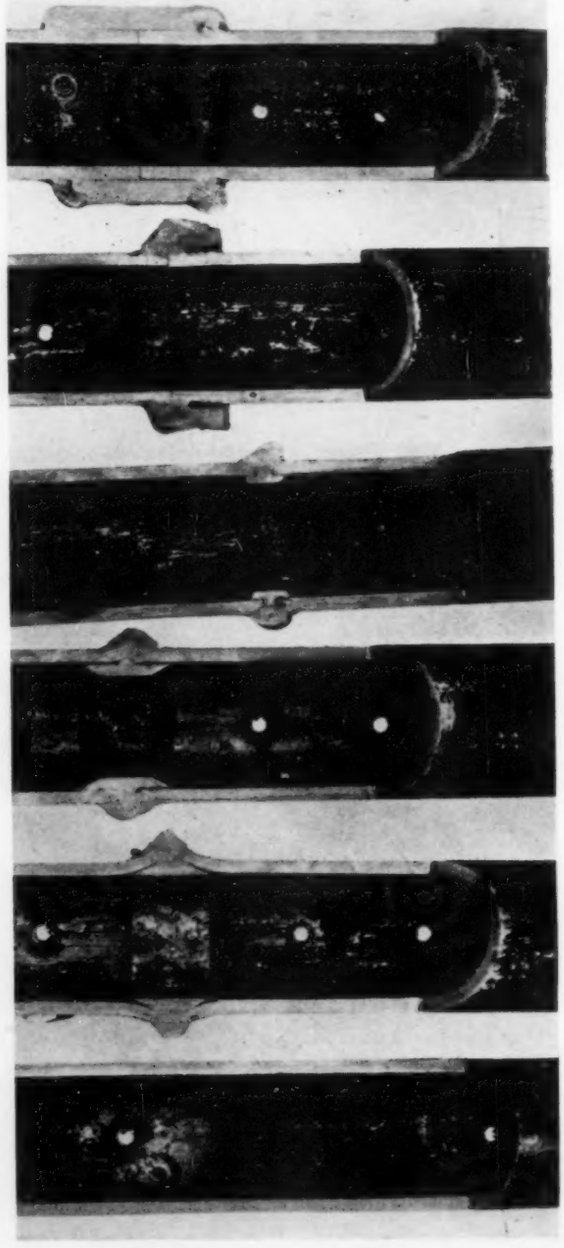


Fig. 6—Bisected Specimens Used in Flow Resistonce Tests

the tube wall does not offer the same difficulties in gas welding as in arc welding. However, the longer heat dwell of gas welding does often overheat the base metal of very thin tubing, causing undesirable grain growth at the fusion zone. Oxyacetylene welding is now permitted on all classes of piping with wall thickness of 0.0625 in. to 0.1875 in., inclusive.

Considerable attention was paid to the determination of the minimum space requirement for welding pipe joints in fixed positions.

This investigation showed that decidedly better work can be produced in position welding, especially when it is performed in cramped quarters by the use of half-length electrodes. It was found that sound welds can be produced consistently, regardless of whether the tube size is 2 inches or 6 inches with 12 inches of clearance between tube and the deck above and between tube and a bulkhead, provided there is practically unlimited space opposite the above-given restrictions, i.e., below and on one side of the tube. The use of the half-length or of the new $^{9}/_{64}$ x 9-inch electrodes appears to be mandatory when welding the restricted portion of the joint. The use of the short electrodes in developing the first pass was found to be advisable both in the restricted and unrestricted portions of the joint. Frequent stopping and starting does not interfere with the development of sound weld metal when properly trained operators are employed.

Welding of Thick-Wall Tubing

The welding of thick-wall tubing also involves the separate investigation of the factors pertaining to tubes of 2-inch I.P.S. and smaller apart from those of $2^{1}/_{2}$-inch I.P.S. and larger.

The material used for high-temperature, high-pressure steam service is a low-alloy steel for which at the time of the performance of the test no welding rods were available for oxyacetylene welding, therefore all welding was performed using the electric-arc method.

The five designs shown in Fig. 7 were the basis of the investigation of welding of small diameter thick-wall tubing.

The non-metallic backing-ring type joint shown in Fig. 7 was in course of this investigation revised as shown in Fig. 8.

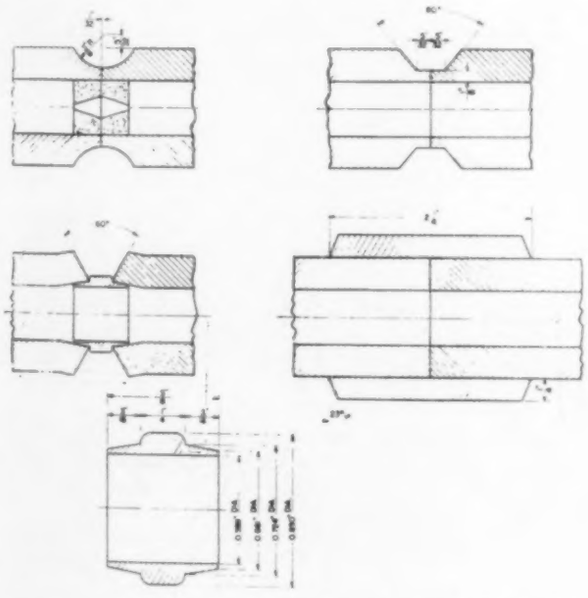


Fig. 7—Designs for Welding Small Diameter Thick-Wall Tubing

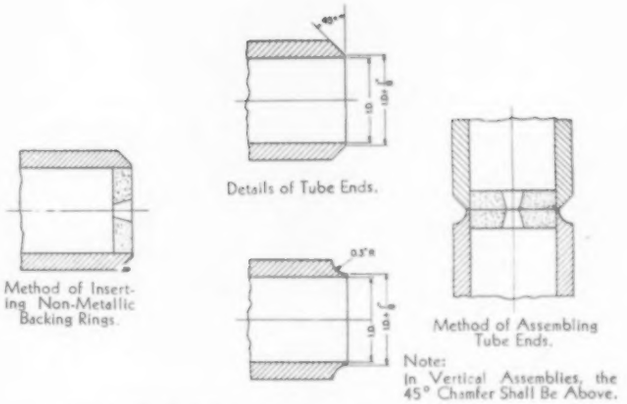

Details of Tube Ends.
Method of Inserting Non-Metallic Backing Rings.
Method of Assembling Tube Ends.
Note:
In Vertical Assemblies, the 45° Chamfer Shall Be Above.

Fig. 8—Revised Non-Metallic Backing-Ring Type Joint

Several materials were used until a mixture was developed which appeared to satisfy the requirements for a preformed nonmetallic backing ring. The rings are produced in suitable dies and are composed about 45% by weight, of a refractory substance and the rest of combustibles. The rings are tapered and are so dimensioned that they fit snugly all tubes of the size and wall thickness for which they are intended as long as the tubes are within the specified tolerance limits.

The rings are hygroscopic and if not used within a few days after they are produced, they must be dipped into a varnish or lacquer to prevent disintegration by moisture pick-up.

In assembling a joint of the non-metallic insert type, the tube ends which are prepared as shown in Fig. 8, receive the non-metallic backing ring which is pushed in until it is flush with the square land or root face. The tube ends are then assembled in tight faying by means of a suitable clamp.

The following welding procedure must be applied in order to obtain full penetration from the start:

While it is not mandatory, it is advisable to draw a round file across the root at a point where it is intended to start welding and remove enough metal to reduce the $^{1}/_{16}$-inch-thick root face to about $^{1}/_{32}$-inch, thus forming a flat spot.

In starting, the arc should be struck against the 45° bevel kerf and led slowly upon the above-given flat spot. On reaching the bottom of the groove, the long, non-depositing arc melts through the thinned-out flat spot forming a hole about the size of the $^{1}/_{8}$-inch electrode used. Then the deposition starts at a rate which permits the maintenance of a hole of the above-given size throughout the entire periphery. In the event the hole tends to enlarge, the welder whips the arc upon the 45° bevel kerf until the crater cools off sufficiently to resume deposition. On the other hand, in the event the hole appears to be diminishing in size, it serves as an automatic warning signal that the rate of progression is too fast.

During the deposition of the first pass the organic portion of the non-metallic backing ring is consumed and the remainder, having lost more than 50% of its density, becomes brittle and friable and collapses and disintegrates under the vigorous tapping which is given the joint in course of slag removal. The residue of the backing ring may be removed by air pressure, flushing or by the use of a cleaning chain.

Figure 9 shows sections and the interior of thick-wall $1^{1}/_{2}$-inch and 2-inch I.P.S. tube joints welded, employing the above-described non-metallic backing rings.

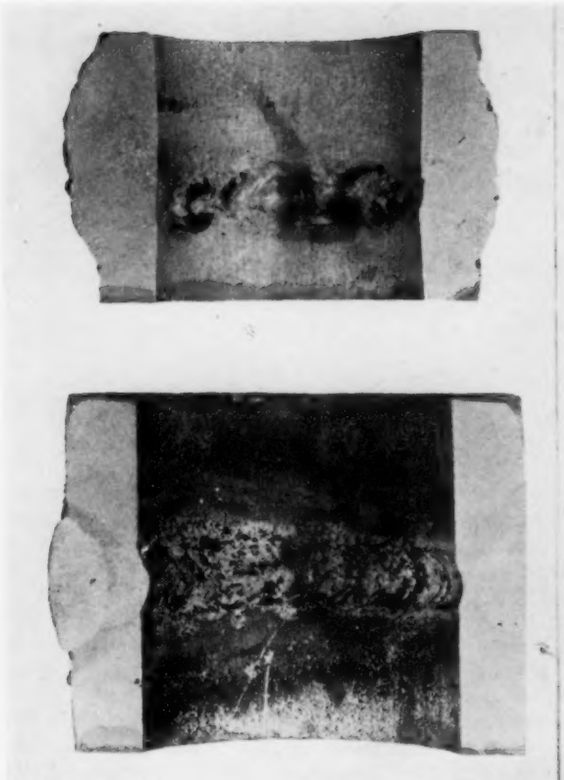


Fig. 9—Interior Thick-Walled Tubing Employing Non-Metallic Backing Rings

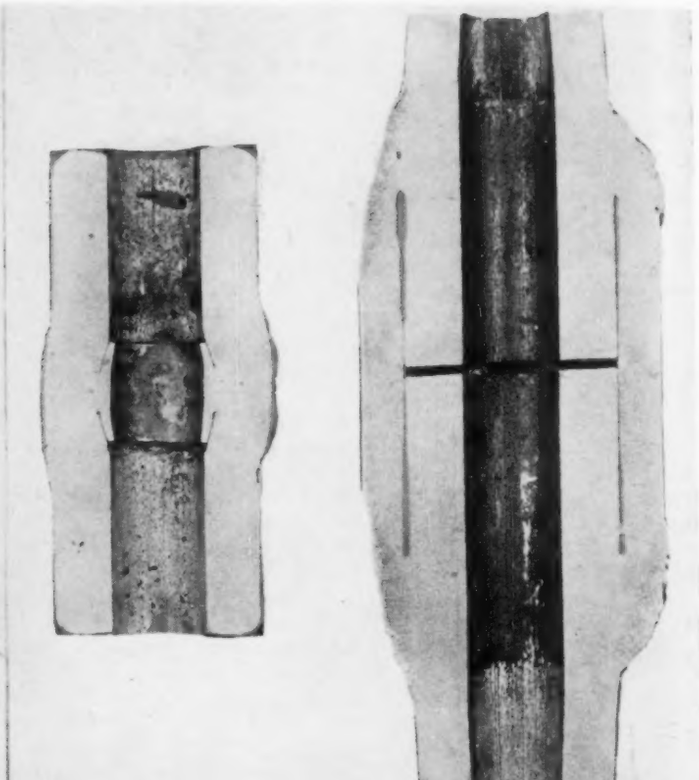


Fig. 10—Sections of Joints in Bureau of Ships and Sleeve Type Joints

The second joint design in Fig. 7 shows the use of the Bureau of Ships type internal, streamline backing ring. In order to expand even standard wall thickness to the extent required to accommodate these backing rings, a special expander must be used and applied after the tube ends are brought to the proper forging temperature. The external sleeve joint was also found applicable.

Figure 10 shows the sections of 1-inch tube joints of the Bureau of Ships and the external sleeve types.

The third design shown in Fig. 7 is for a composite, streamline joint. The $^1/_8$-inch-thick root faces shown at the center of the groove were fused together by the Thermit pressure welding process forming a solid backing ring upon which the weld metal was deposited by arc welding in the usual manner.

Figure 11 shows the assembly in preparation for the Thermit pressure weld. The two-part cast-iron mold is shown over the joint and the special cast-steel clamps are holding the tubes in alignment. The two wrenches set upon the draw bar nuts are used to exert the required pressure after the liquid products of the Thermit reaction are poured into the mold and transfer a portion of their heat content into the tube within the mold, bringing the former to a white forging heat. The entire procedure of reacting, pouring, heat transfer period and upsetting of the joint takes less than 3 minutes exclusive of the time needed for aligning the joint and the removal of the clamp, the mold and the solidified and fully separated products of the Thermit reaction. In the event that the mold is removed before the fused root portion cools below 300° F., and if arc welding starts immediately upon removing the clamp, the metal forming the backing ring under the first pass becomes fully recrystallized leaving no trace of the fusion-welded root.

Figure 12, shows sections of $1^1/_2$-inch and 2-inch I.P.S. X-heavy tube joints of the above-described composite design.

The photomicrographs, Fig. 13, show, left, the grain structure of the recrystallized stratum of fusion-welded root; center, the fusion zone between filler and base metals; and on the right, the unaffected base metal of the tube.

The above-described composite joint was successfully applied from 1-inch XX I.P.S. to and including 2-inch X I.P.S. tube sections. The Thermit portions varied from 2 lb. 6 oz. to 4 lb. 3 oz. for the 2-inch X I.P.S. joint which was preheated to 450° F. Thermit pressure welds may be successfully applied in any position.

The advantages of the composite joint are good streamlining and full penetration at the root zone; the disadvantage is the necessity of carrying from joint to joint the somewhat cumbersome equipment.

Welding of Thick-Wall Tubing, $2^1/_2$-Inch I.P.S. and Larger

The joint designs employed in industrial fabrication of high-pressure, high-temperature piping were investigated and on the basis of the findings three types of designs were selected for further study. The details of the three designs are shown in Fig. 14.

The joint identified as Type I is the open root "U" design employing a $^1/_8$-inch thick medium steel backing ring welded with a fillet into the tube end which in the joint represents the inlet.

The Type III joint contains the conventional 60° included angle groove and it employs a $^3/_{16}$-inch thick medium steel backing ring, which too is welded into the inlet side.

The Type II joint employs a non-metallic backing ring and is of the same design as used in connection with the preformed non-metallic backing rings given for the small diameter tubes.

The investigation of the Type I design concerned itself mostly with the effect of root spacing upon the degree of fusion obtainable at the root zone. The spacing was varied from $^{3}/_{32}$ inch to $^{5}/_{32}$ inch.

On the basis of previous tests the Type III joints produced were assembled with a minimum root spacing of $^{5}/_{16}$ inch, having found that no sound root conditions were obtained consistently in 60° included angle joints assembled with a narrower root spacing.

As shown in Fig. 14 the Type I and Type III joints were modified for vertical assemblies as indicated. This was done on the basis of experience which showed that the modification of the joint enables the consistent production of sound welds in the vertical. The reason for modifying the joint design for vertical work becomes evident from the schematic presentation of the applicable pass sequence shown in Fig. 15. In horizontal work either in the fixed position or with the assembly rotated, it was found desirable to develop the weld metal in the least number of passes, depositing each electrode with the maximum current rate applicable and keeping each increment as short as possible without undercutting. This method prolongs the current dwell and tends to heal any occasional defect which may develop through a partial loss of the arc intensity which occurs periodically in manual welding.

In vertical welding the above-given procedure cannot be applied to such extent as in horizontal assemblies for the contour formation of each pass in the vertical is asymmetrical, a condition which results in overlapping unless the volume per pass is reduced.

By depositing each pass with a weaving motion along a zigzag path inclined about 45° from the vertical, it is possible to partly satisfy the requirement for increased current dwell without incurring the danger of overlapping.

The material used for the non-metallic backing ring of the Type II joints was a refractory applied by means of a spatulum, or putty knife, in the form of a thick, watery grout. This refractory air sets in 6 to 8 hours or may be set in a few minutes by artificial dehydration using an oxyacetylene torch for this purpose. The set refractory is dense and durable and permits handling of the tube containing it with no more care than that required to keep the machined ends from being deformed.

The procedure given in connection with welding the first pass of joints containing preformed, non-metallic backing rings fully applies to those containing the non-metallic backing rings applied plastically in the Type II joints formed by tubes of larger than $2^{1}/_{2}$-inch I.P.S. The non-metallic backing ring of the Type II joint does not disintegrate on completion of the first pass, in fact the heat input of the latter makes it even stronger and harder by complete dehydration. However, because the coefficient of expansion of the refractory is greater than that of the surrounding steel ring in course of the stress-relief treatment it shatters and is then easily removed by any suitable appliance. Figure 16 shows sections of these joints produced in the horizontal rotated and in the vertical fixed positions, respectively.

The material used in connection with the investigation of the above-given three types of tube joints was a low-alloy tubing of 4-inch and 6-inch I.P.S. and of $^{5}/_{8}$-inch and $^{3}/_{4}$-inch wall thickness, respectively.

The evaluation of the effect of the root spacing upon the soundness of the root zone was performed in conjunction with the study of the influence of the complete absence and of the various degrees of preheat upon the soundness of the deposit.

The effect of preheating was examined in regard to its influence in producing sounder weld metal and it was found that by promoting greater fluidity in the crater, it permits the floating out of the slag at all times. The effect of preheating in regard to the residual stress at the weld zone was also examined, and it is discussed in the portion of the paper dealing with stress considerations.

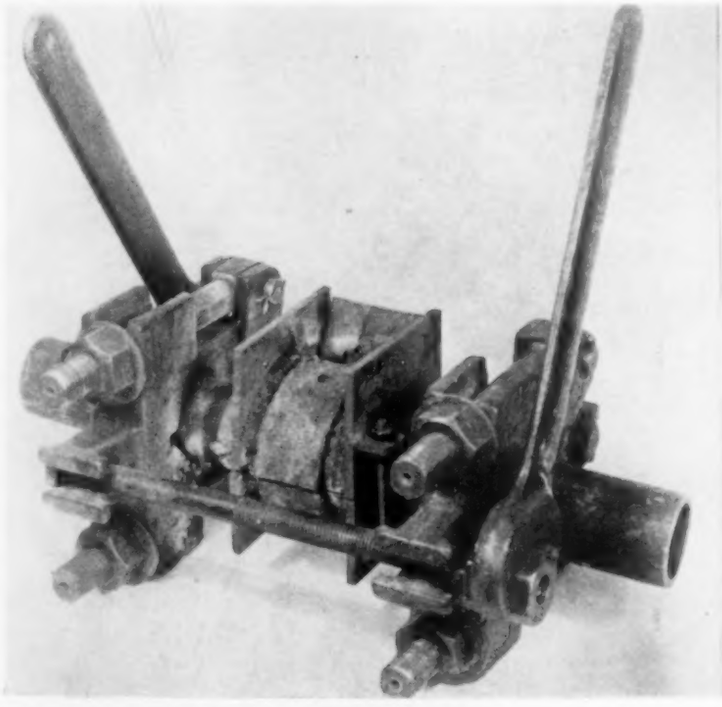


Fig. 11—Assembly in Preparation of Thermit Pressure Weld

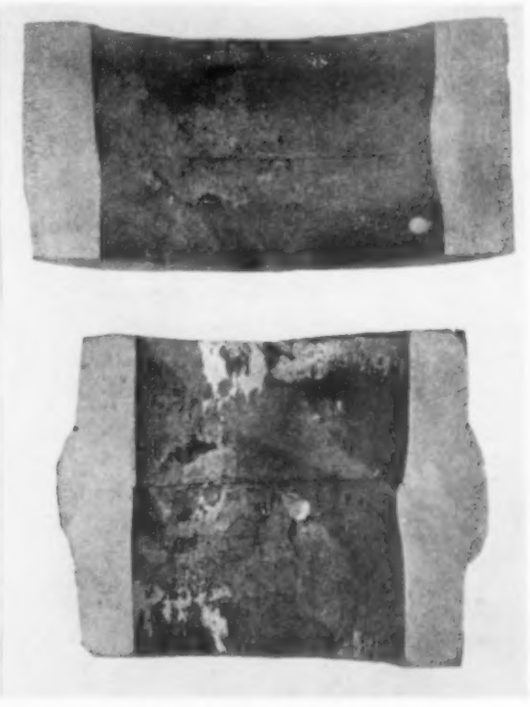


Fig. 12—Heavy Tube Joints Made by Thermit Pressure and Arc Welding

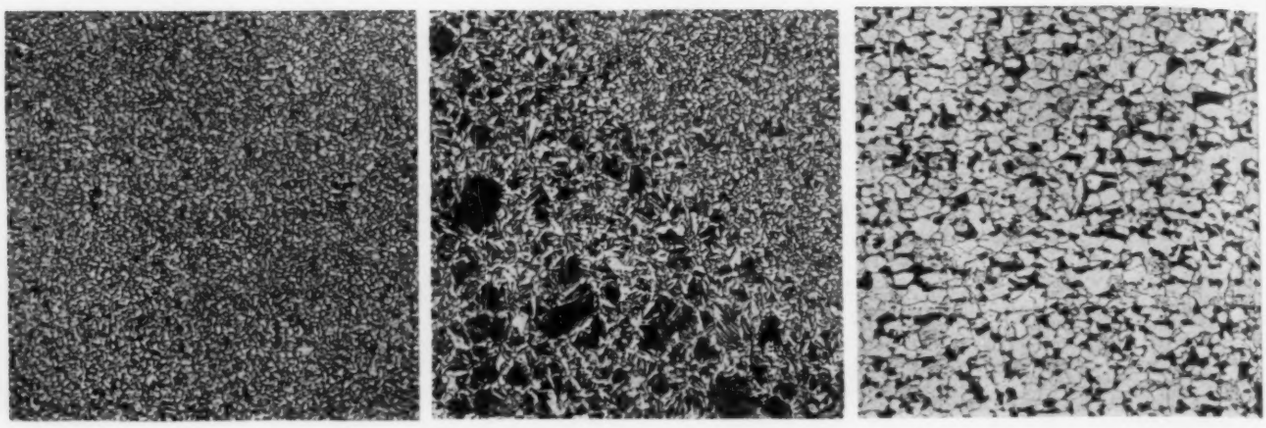


Fig. 13 (Left)—Grain Structure of Recrystallized Fusion Weld Root; (Center)—Fusion Zone Between Filler and Base Metals; (Right)—Unaffected Base Metal

During the early phases of the test it was found that several root-bend specimens containing portions of the entire volume of asssembly tacks failed. Examinations of these failures showed that remelting of tacks, especially of those deposited into unpreheated assemblies, is not always successful. The outcome of this phase of the investigation was the designing of clamps suitable for various types of assemblies, such as tube to tube, tube to flange and elbow to tube or elbow to flange. The clamps were so designed that while they were sufficiently rigid to prevent loss of alignment during welding, their weight was not objectionable. In addition to the primary task they were meant to serve, namely, to hold the assembly in the required position, they were useful as temporary hangers. They were designed with sufficient clearances to permit mounting of equipment for preheating, and when left in place as temporary hangers they aid in carrying out the stress-relief treatment without loss of alignment.

Figure 17 shows a typical welding clamp designed to satisfy the above-given requirements.

By the use of clamps, tack welding is fully eliminated, thus promoting uniform soundness at the all-important root zone.

Approved Designs for Welding Tubing

The final designs for welding tubing for Naval use as approved by the Bureau of ships, Navy Department, are shown on Figs. 20(*b*), 20(*c*) and 20(0). These designs were based on the results of the above given investigations.

Residual Stresses in Tube Welds

The matter of residual stresses in welded tube joints is a moot question. There is a body of engineers who while admitting the presence of the stresses fail to attribute any significance to this phenomenon, others remain adamant in their belief that the stresses reported in some welded pipe joints reach the value stated by various investigators.

At the present most code-formulating bodies acknowledging the presence of residual stresses in welding specify a stress-relief treatment regardless of whether the joint was preheated or not.

The value of the residual stresses in pipe joints is readily demonstrable and by destructive methods the components of the residual stress may be determined with fair accuracy.

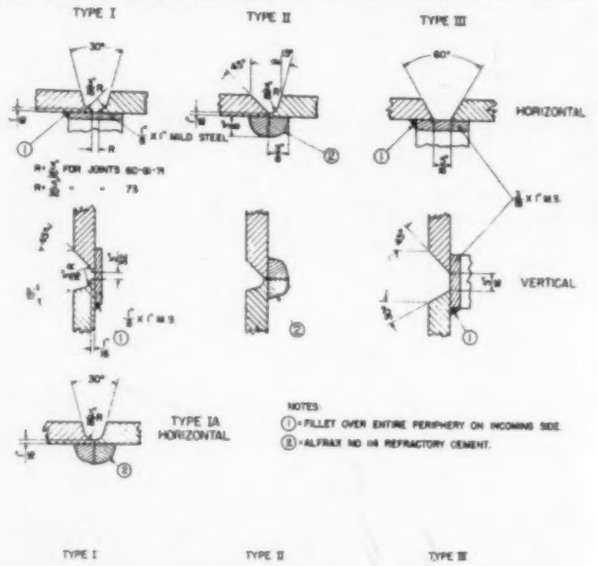
It appears that as long as the presence of the localized stress condition is acknowledged, it is good sense to remove that stress even though at the present there are no data on hand on whether or not an early failure will beset the non-stress-relieved tube joint installed into high-pressure, high-temperature steam lines.

For the qualitative determination of the character and the magnitude of the residual stresses in tube welding, the Welding Laboratory of the Engineering Experiment Station devised the following demonstration:

The basis of the demonstration is the principle which pertains to the magnetic susceptibility of common steel under varying stress conditions.

The effect of changing stress conditions upon the

Fig. 14—Joint Design for High-Pressure, High-Temperature Service



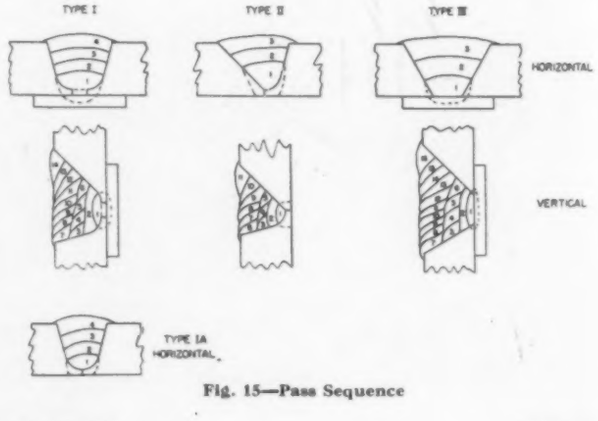


Fig. 15—Pass Sequence

Fig. 16—Joints Produced in Horizontal Rotated and Vertical Fixed Positions

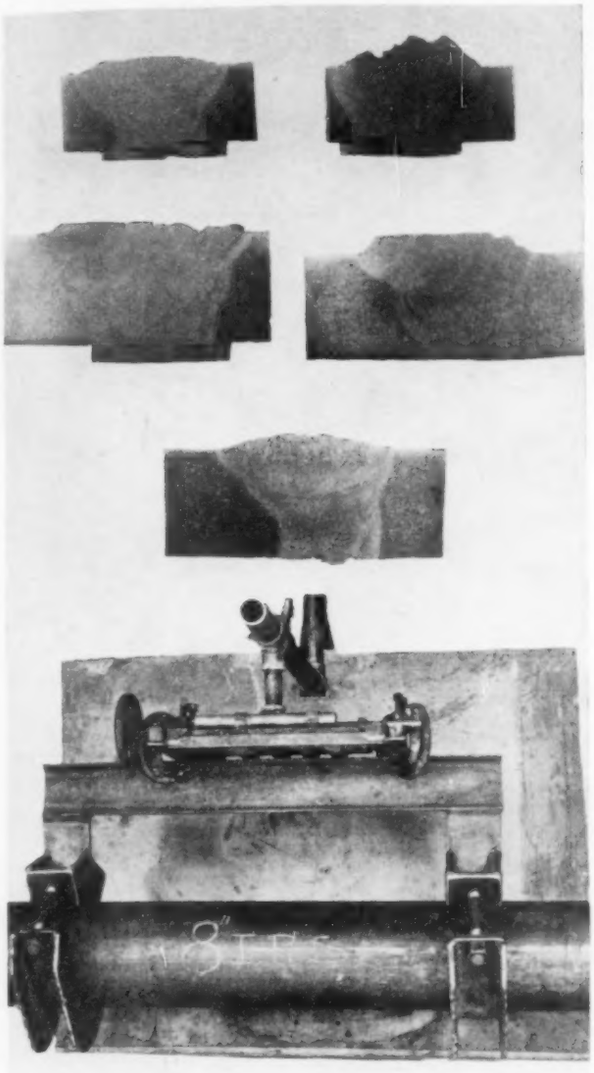


Fig. 17

magnetic response of medium steel or of any of the low-alloy steels used as tube material in high-temperature, high-pressure steam service is demonstrable by means of magnetic analysis.

The method known by the above-given term employs usually two sets of transformers whose calibrated primaries are connected in parallel and the secondaries, which are wound in opposite direction, are connected in bucking series. When the cores inserted within the two coils are identical in all respects the output of the two coils is also identical and since they are bucking one another; i.e., they are at 180° in phase relationship the output of one cancels the other and the image obtained on the viewing screen of an oscillograph or an oscilloscope is as shown in Fig. 18.

The first set-up of the demonstration was two $^1/_4$-inch diameter steel rods cut from one length. One of the rods is inserted within one coil and the other is incorporated in a simple dynamometer consisting of non-magnetic members.

When the rod within the dynamometer is not loaded, the oscillogram obtained is as that in Fig. 18. When load is applied upon the latter rod, the oscillogram distorts and at the stress of 25,000 psi the image is as shown in Fig. 19. The peak of the wave grows in straight proportion with the increase of the stress. On lowering the stress the peak diminishes until at 0 stress the original image reappears. As long as stress applied is within the elastic limit the above-given phenomenon may be recreated repeatedly.

It shows that the stress impressed upon magnetizable materials directly affects the magnetic properties thereof.

The second part of the demonstration employs four pieces of tubing each representing one-fourth part of a standard length.

Section No. 1 is as cut off, the ends of No. 2 are prepared to permit the development of hydrostatic pressure within this section. The third part was cut in two and then reunited by welding, and it was used with the reinforcement removed.

The last portion also was halved and the halves were reunited by welding, after which it was locally stress relieved.

Using the above-given four tube sections the procedure is as follows:

At first the two unwelded tube sections are compared by magnetic analysis, which yields an oscillogram of about the same character and amplitude as shown in Fig. 18.

Then the No. 2 tube section is stressed hydrostatically until a hoop stress of 25,000 psi is obtained, which results in the development of a stress peak on the oscillogram having the same general appearance as that shown in Fig. 19. Then the tube section which is in the as-welded condition is substituted for the No. 2 and it is noted that the oscillogram is of the same general character as was noted for No. 2 loaded until a hoop stress of 25,000 psi was reached, except that for the welded joint the stress peak appears to extend beyond the screen of the oscilloscope, indicating that the stress of the as-welded tube probably exceeds 25,000 psi.

Finally the stress-relieved section is substituted for No. 3 and the image again returns almost to its original amplitude showing a peak which may be evaluated at 2500–3000 psi.

The information concerning the X-ray method for non-destructive, quantitative determination of the re-

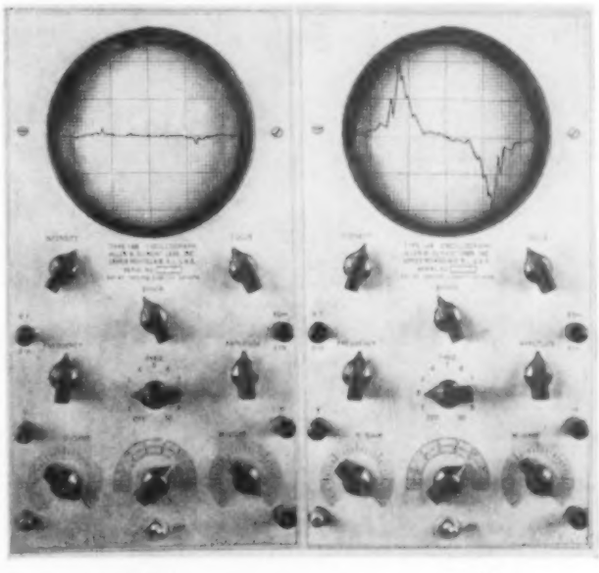


Fig. 18 Fig. 19

sidual stress in welded pipe joints is very meager and apparently had no practical application in this country. Earlier reports indicate that in Germany the back-reflected method of diffraction was used to some extent to determine the stresses in loaded structures, such as bridge members.

The usual method practiced in this country for the quantitative determination of the residual stresses in tube welding is a destructive process, based on the theory of relaxation.

According to this theory if a structure containing locked-in stresses is parted in a direction at right angle to the plane of any one stress component the structure on parting deforms to the extent which satisfies the value of that particular component. Thus, it appears that each specimen available for test purposes is capable of yielding information in regard to only one stress component. However, under the circumstances, as in tube joints, the value of at least two components may be determined from a single specimen. The method used for this purpose, as developed at the Experiment Station, is indicated in Fig. 20.

The tube sections used for the relaxation test contained the weld at mid-length and extended on both sides 2 to 3 inches beyond the heated zone. Companion specimens of equal length contained non-stress-relieved joints and comprised of unwelded tube sections.

The operations as indicated by Fig. 20 were: first, the machining of the flat land, the milling of the parallel slots, the gaging of the distance between the outer walls

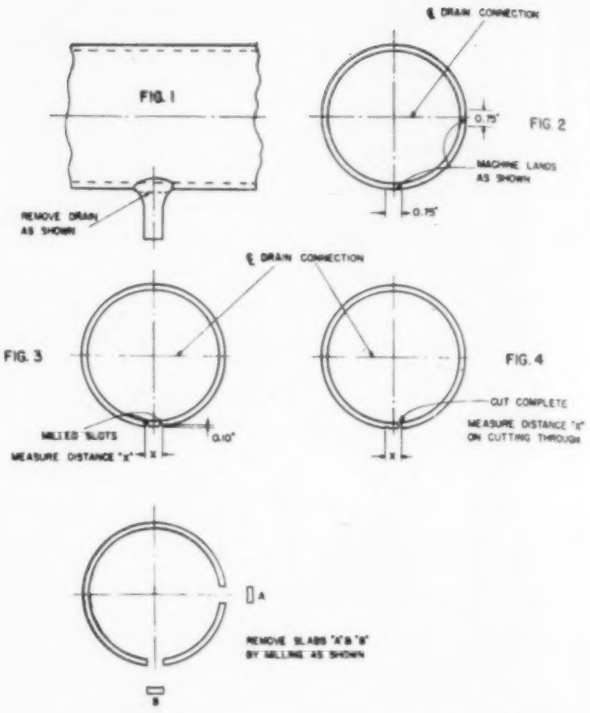
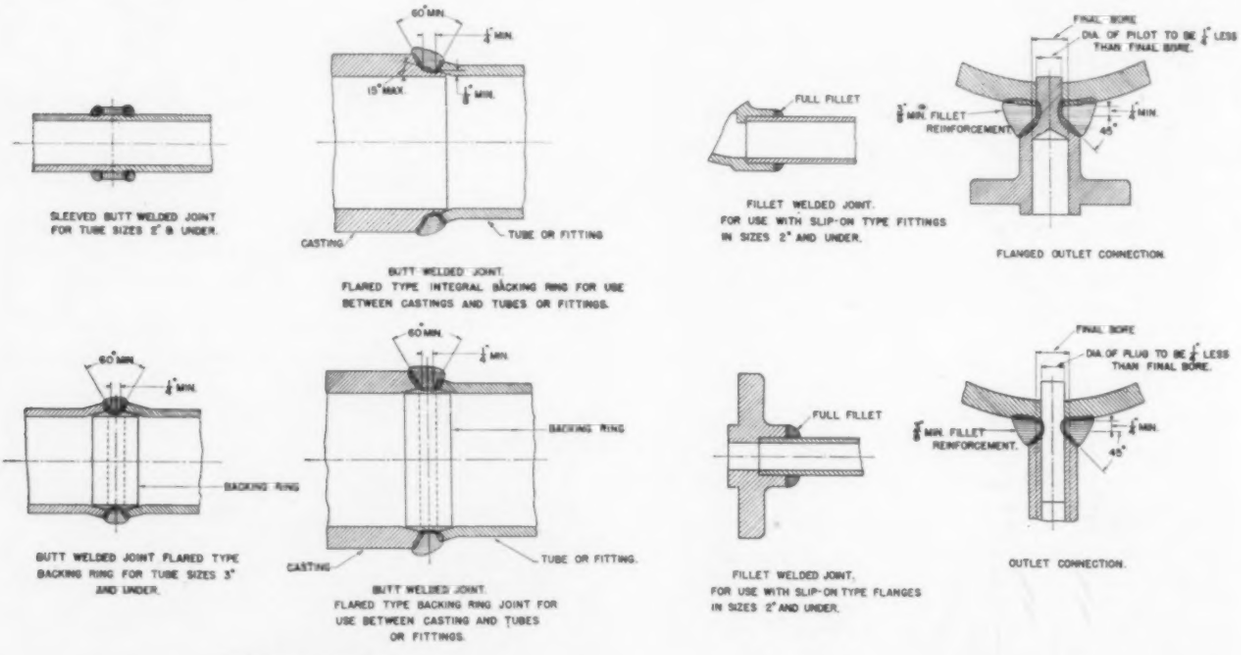
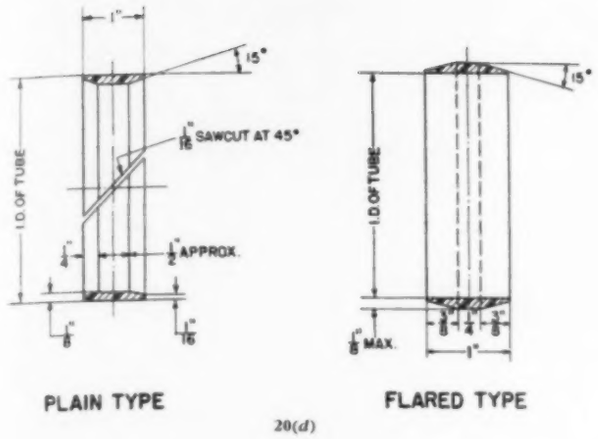


Fig. 20(*a*)—Measuring Residual Stresses in Tube Joints by Relaxation Method


SLEEVED BUTT WELDED JOINT FOR TUBE SIZES 2" & UNDER.
60° MIN.
1/4" MIN.
15° MAX.
1/8" MIN.
CASTING
TUBE OR FITTING
BUTT WELDED JOINT. FLARED TYPE INTEGRAL BACKING RING FOR USE BETWEEN CASTINGS AND TUBES OR FITTINGS.
FULL FILLET
FILLET WELDED JOINT. FOR USE WITH SLIP-ON TYPE FITTINGS IN SIZES 2" AND UNDER.
FINAL BORE
DIA. OF PILOT TO BE 1/4" LESS THAN FINAL BORE.
1/8" MIN. FILLET REINFORCEMENT.
1/4" MIN.
45°
FLANGED OUTLET CONNECTION.
60° MIN.
1/4" MIN.
BACKING RING
BUTT WELDED JOINT FLARED TYPE BACKING RING FOR TUBE SIZES 3" AND UNDER.
60° MIN.
1/4" MIN.
BACKING RING
CASTING
TUBE OR FITTING.
BUTT WELDED JOINT. FLARED TYPE BACKING RING JOINT FOR USE BETWEEN CASTING AND TUBES OR FITTINGS.
FULL FILLET
FILLET WELDED JOINT. FOR USE WITH SLIP-ON TYPE FLANGES IN SIZES 2" AND UNDER.
FINAL BORE
DIA. OF PLUG TO BE 1/4" LESS THAN FINAL BORE.
1/8" MIN. FILLET REINFORCEMENT.
1/4" MIN.
45°
OUTLET CONNECTION.
60° MIN.
1/4" MIN.
FILLET WELD UPSTREAM END ONLY, TACK OR CONTINUOUS. FOR POSITIONING BEFORE ASSEMBLY.
BACKING RING
BUTT WELDED JOINT. PLAIN TYPE BACKING RING FOR TUBE SIZE 3 1/2" AND OVER.
40° MIN.
FILLET WELD UPSTREAM END ONLY, TACK OR CONTINUOUS. FOR POSITIONING BEFORE ASSEMBLY.
1/8" MAX.
1/4" MIN.
1/8" MIN.
BACKING RING
U-GROOVE EDGE PREPARATION MAY BE USED IN LIEU OF V-EDGE PREPARATION ON JOINTS, FIGS. 62, 63, 64 AND 65.
BACKING RING
60° MIN.
1/4" MIN.
1/4" MIN.
1/8" MIN.
BUTT WELDED JOINT. FOR USE BETWEEN TUBE AND WELDING NECK FLANGE. BACKING RING SHALL BE REMOVED BY MACHINING AFTER WELDING.
45°
1/8" MIN.
1/4" MIN.
1/8" MIN.
1/4" MIN.
SPLIT OR SOLID RING MAY BE USED
OUTLET CONNECTION. BACKING RING SHALL BE REMOVED BY MACHINING AFTER WELDING.

20(*b*) 20(*c*)



20(*d*)

Fig. 21—Arrangement for Preheating Tubing

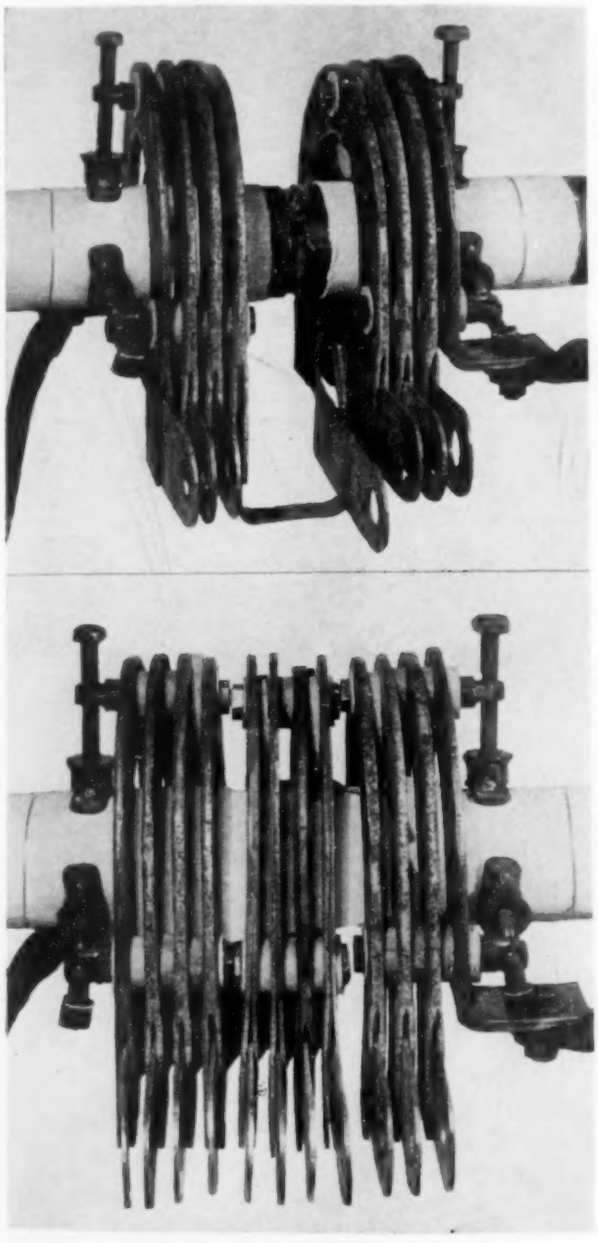


Fig. 22—Arrangement for Stress Relieving

of the slots at stated intervals, cutting through one slot, releasing the assembly and the final gaging of the distance between the outer walls of the slots. The last operation was the removal of the flat land-topped slab by cutting through the second slot. The milling of slots is performed at a slow rate using a light feed only. The sign of the stress is determined from the behavior of the specimen on cutting through the first slot. In the event that the locked-in stress is compressive, or positive, the slot tends to close and the distance between the outer walls of the grooves diminishes. When the locked-in stress is tensile, or negative, the tube opens up and the distance between the groove walls increases.

In accordance with Castigliano's theory a portion of the tube section may be regarded as a curve beam whose deflection is one-quarter of that noted for the entire system. Knowing the diameter of the tube, the wall thickness and the deformation, the load which causes the given deformation of a curved beam may be computed from the formula $P = 4IEd/\pi R^3$ where I = the moment of inertia of a unit length of the beam, E = the modulus of elasticity of the material used and R = the radius of the tube section, and "d" one quarter of the total deflection observed. Having determined the load the stress may be readily computed in the usual manner for cantilever beams.

To check the results obtained by computation, the entire section is put between the plates of a tension machine in such manner that the center line of the slot is in the horizontal plane and then it is compressed back to the original diameter. The value of the load obtained by computation for a unit length of the assembly multiplied with the total length in inches and by two is usually found to be within less than 8% of that obtained by the compression test.

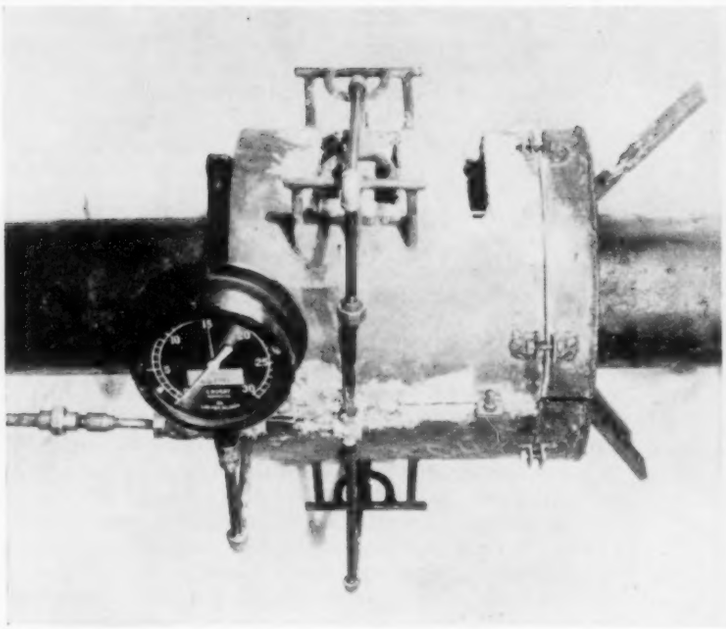
The value of the axial component is determined from the data obtained by carefully measuring and plotting the deformation of the relaxation bar removed from the assembly. The curve of the neutral axis of this beam as plotted from the measured deflection indicates whether the bar may be regarded as a simple beam freely supported and centrally loaded, or if it represents some other identifiable condition. Upon having determined the applicable beam condition the load and the corresponding stress are computed in the usual manner. The physical check upon these specimens consists of loading them in the manner indicated by the deformation curve with the specimen set upon a parallel bar. The load is applied in small increments and is increased until the deformation disappears. The load is then removed, the deflection remeasured and then the load is reapplied for a final check. The results of this test usually agree within 5% with those obtained by computation.

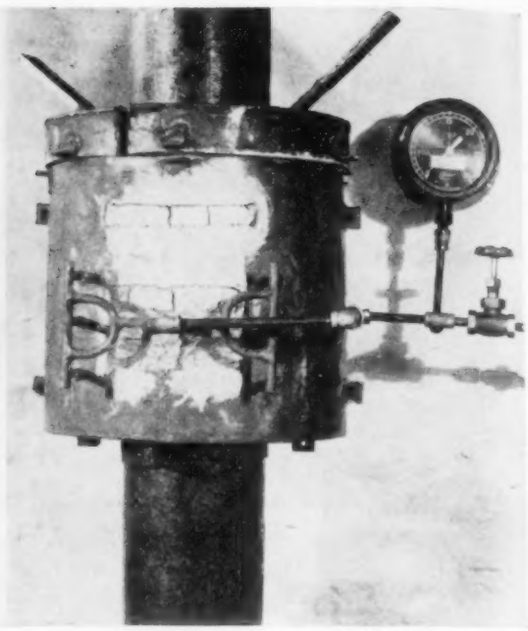
Stress-Relief Treatment

Results of tests show that preheating a pipe joint does not necessarily result in lowering the residual stresses; to the contrary, in larger and especially in heavy-walled tube assemblies the opposite may happen. This is contrary to the general belief and experience in regard to the relationship between preheat and residual stress development. However, a brief analysis of the situation may suffice to clear up the paradox contained in the above-given statement.

When the tube ends assembled to form a joint are locally preheated they expand in proportion to the degree of preheat. The weld metal is deposited into a groove formed by the expanded tube ends.

On completion of the weld it begins to cool and, therefore, to contract. The weld metal, being in the shape of an annular ring, shrinks more circumferentially than





Figs. 23 and 24—Device for Radiation Heating of Tube Joints

axially. The expanded condition of the preheated tube ends partially prevents the free contraction of the weld metal until the temperature of the latter equals that of the surrounding base metal whence the further free contraction is again prevented by the stiffness of the unpreheated portion of the tubes. Thus, the residual stress is built up in two stages within the weld metal. However, since practically all tube joints produced for high-temperature, high-pressure service are stress relieved, the development of a fairly high residual stress in preheated welds is of no particular importance. Preheating has distinct advantages from the metallurgical point of view, especially when the materials used are more or less subject to air hardening, in so far that it prevents or reduces the danger of development of an undesirable grain structure at the fusion zone. Another, and just as important, advantage of preheating is that a greater volume of weld metal may be kept liquid in the crater and that the heat inertia of this greater volume of liquid metal enables the venting of occluded gases. The heat inertia of the large pool of liquid metal reduces the harmful effect of the occasional and well-nigh unavoidable arc irregularities which are regarded as the sources of defects in arc welds.

The elevated temperature of the base metal prevents the instantaneous chilling of the slag and, thereby, enables the metal below the slag cover to level itself. Thus, the appearance of the deposit in a preheated weld is better, being smooth and free of coarse ripples. This in turn is a very effective aid in the development of superimposed passes, as it is so much easier to maintain a steady arc on a smooth surface.

In the course of this investigation it was found that tube material received in the annealed condition contained circumferential residual stresses of the order of 25,000 psi. It is believed that these stresses were developed in straightening cold after annealing. The behavior of this material was very unsatisfactory when welded without preheating in so far that the residual stress remained at a high value, the ductility and the tension impact value obtained from transverse specimens were too low for the material used. A portion of the above-given material was pre-stress relieved and companion joints were welded. The results of the test of these specimens showed lower residual stress values for both components determined. Likewise, the ductility and the tension impact values increased.

The efficacy of the various types of equipment whose suitability for local stress relieving of welded tube joints was determined using the above-described relaxation method.

Two types of equipment were investigated; namely, apparatus for heating by radiation and by induction.

It was found that under favorable circumstances both methods are capable of performing the task of local stress relieving; namely, by reducing the value of both components to less than 5000 psi without the introduction of new stresses at the transition zones between heated and unheated portions.

The investigation found that the induction method is more reliable than the radiation type heating devices in so far that:

(*a*) It insures uniform temperature throughout the wall thickness.
(*b*) The thermocouple readings indicate true temperatures.
(*c*) It permits the development of a slowly graduated temperature distribution from the weld zone to the ends of the heated zone.
(*d*) It appears to be the safest.
(*e*) The devices developed for this purpose are rugged and require a minimum of maintenance.
(*f*) The apparatus can be assembled at a considerably lower cost than that of the radiation heating equipment.

The Station developed a fixed type of induction coil which is composed of three sections. For preheating, only two sections are applied spaced equidistant from the joint and separated at a distance which equals the length of the center portion. During preheating, the two sections are connected with a jumper, as shown in Fig. 21. For stress relieving, the center section is mounted as indicated in Fig. 22.

The construction of these coils is very simple; they are rugged and because of the low operating temperature have a long life.

As the magnetic field between the coils during preheating is very strong, induction heating cannot be maintained during welding. It was found fully satisfactory to preheat to 400–500° F. depending on the wall thickness and the size of the assembly, and to complete the joint in one operation without reheating for the temperature under such circumstances does not fall below 350° F.

The use of the wrapped cable for induction heating gave equal satisfaction in regard to the efficacy of stress relieving. The following disadvantages were found in its use:

(*a*) The time required to wind the required number of turns and to insulate the turns from one another.

(*b*) The frequent necessity for re-annealing of the cable which stiffens from the cold work of repeated winding.

(*c*) The recalibration of the power input on repetitive joints which becomes necessary for the inability of winding the cable with the same pitch.

The wrapped cable is particularly suitable for use in other than straight joints.

The Station's experience in using the non-inductive resistance heating coils was not particularly successful. It was found that when judiciously controlled it is capable of performing the task in a satisfactory manner, especially when the wall thicknesses are less than 0.75 inch.

The following disadvantages were found:

False temperature indications in the event that a thermocouple was exposed to direct radiation. This is preventable by introducing a layer of insulation below the heating coil. In the event that the latter method is used, the heat transmission into the heated object is delayed, resulting in overheating and the eventual burning out of the coil. The latter event may cause it to burn through the thin layer of insulation grounding the 220-volt circuit on to the tube and possibly burn into it. The grounded 220-volt circuit may seriously endanger the operating personnel or anyone who may come in contact with the grounded portion of the line.

The proper application of the indirect electric resistance heating method calls for the use of three coils in

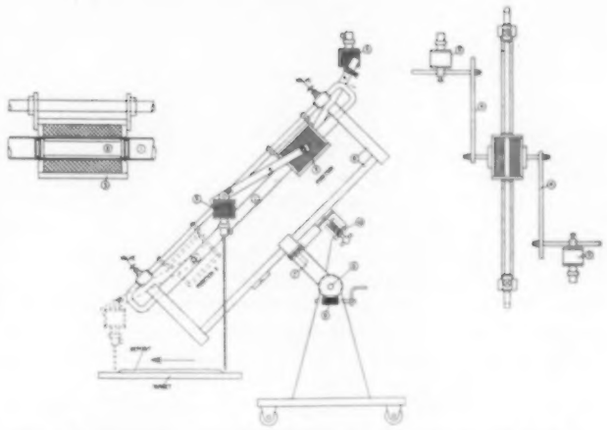


Fig. 25—Semi-Automatic Machine for Welding Tube Joints

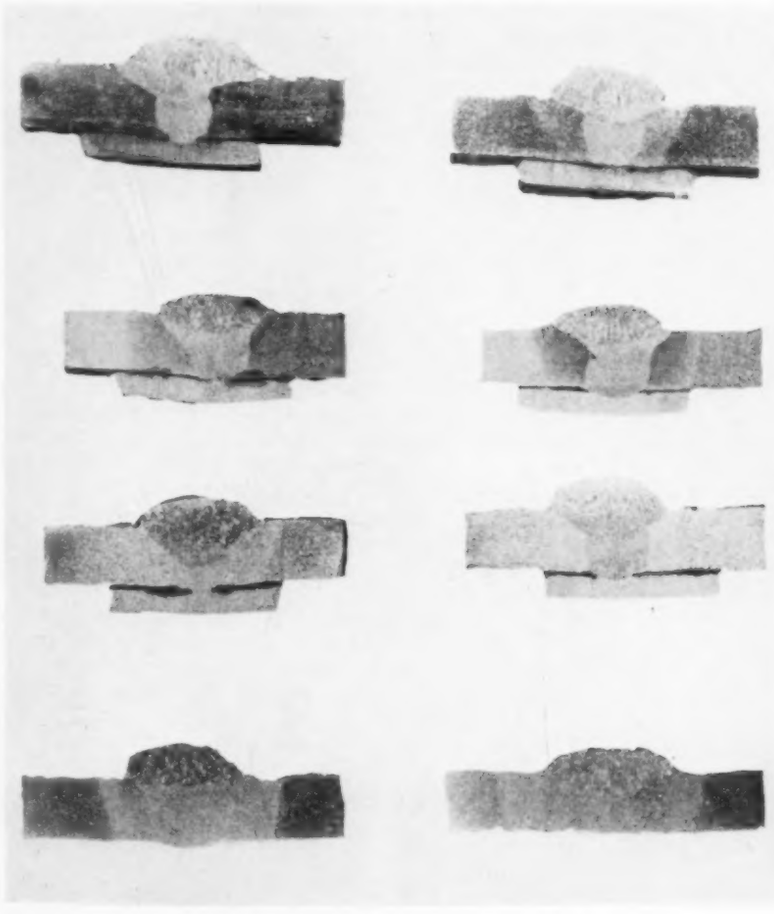


Fig. 26—Welds Made by the Automatic Welder

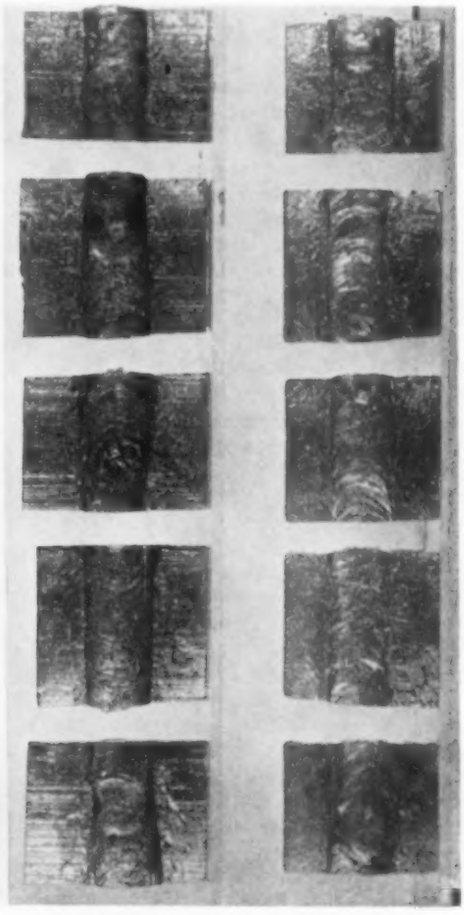


Fig. 27—Appearance of Finished Joints Made by the Automatic Welder

parallel requiring three individual control devices or a single apparatus capable of controlling three independent circuits.

Sectional furnaces heated by electric resistance units are preferable to the flexible coils in so far that the possibility of getting false temperature readings is practically eliminated, and they are safer than the loose coils. The disadvantage of these furnaces is the uncertainty of heating through the wall thickness and their lack of flexibility for other than tube to tube joints. Their regulation requires the same costly control apparatus as that given above for the loose coils.

The Station developed a simple device for radiation heating whose performance is fully comparable to that of any other apparatus functioning by means of heat transfer by radiation.

Figures 23 and 24 show applications of this device, a sectional charcoal furnace operating under artificial draft installed either horizontally or vertically. By regulation of the air admission, the furnace performance may be kept under close control. The apparatus may be made to function automatically by substituting a solenoid-operated valve for the manually operated throttle shown in the photograph. The principal advantage of this device is its very low cost; its disadvantages are the small volume of fumes liberated during its starting period and principally the possibility, especially when used for treating heavy-walled tubes, of developing a higher temperature in the outer fibers than is obtained on inner fibers of the heated tube section. The apparatus is fairly flexible, it being adaptable for vertical, horizontal and for Tee joints of the same size or in combination.

In course of the investigation of stress-relief treatment it was found that no commercial equipment was readily adaptable for the convenient establishment of a desired heating or cooling rate without resorting to manual control.

To overcome this handicap the development of a device was undertaken which is to maintain automatically any predetermined heating or cooling rate up to 500° F. per hour provided the necessary power input is available. The device is designed to be useful in conjunction with most recording or indicating type of commercial pyrometer control devices.

Tests

Process Qualification Tests.—Before any contractor (Navy Yards are regarded as contractors in the same manner as are commercial shipbuilders) is authorized by the Navy Department to proceed with the fabrication of welded piping, its process for its production must be demonstrated. For the purposes of the qualification test on welding high-pressure, high-temperature piping, four samples are required, two specimens are 2-inch I.P.S. or smaller, and two are 6-inch I.P.S. One of each type has to be welded in the fixed horizontal, the other in the vertical. The specimens are accompanied by data sheets, which contain information pertinent to the joint design used, the pass sequence, preheat, current rates and electrode sizes used, also the name of the welder who produced the specimen.

The basic tests performed with these specimens are visual examination, root and face bends, transverse tension test, metallographic examination and chemical analysis of the weld and base metals. The specimens are submitted in the stress-relieved condition, but as they are only 12 inches long the heat treatment is generally performed in a furnace. It is now contemplated to have the test specimens heat treated, using the stress-relief equipment which is intended to be used in the course of production for those joints which will have to be locally treated.

The qualification test is very strict and rejections occurred based on deficiencies which the performance of the physical tests did not demonstrate.

The principal requirement for the joints in high-temperature, high-pressure steam lines is soundness throughout all strata of the welds. Neither root nor face bend tests are sufficient to reveal lack of soundness within the interior of the weld, nor is it apparent from the results of the transverse tension tests, unless the weld was produced by an apprentice. It was found that examination of the transverse metallographic specimens yields a fair indication in regard to soundness. When the latter, of which generally one is provided for each quarter, indicates lack of soundness, then the unused portions of the specimens are mounted on a suitable arbor and the weld is machined off in increments of 0.015 inch. On the removal of each increment the defects revealed are carefully plotted and from this chart the soundness of the filler metal is evaluated with fair accuracy.

The welder's qualification test is restricted to the performance of two root and two face bend specimens taken from specified locations. Examination of metallographic specimens is optional.

Non-Destructive Tests.—The tentative specifications for the inspection of welds in high-pressure, high-temperature piping include two non-destructive tests, namely, x-ography and the magnetic powder method. The efficacy of these methods is still under investigation.

The use of the Arcronograph method of inspection in the course of production, and as means to speed up training, was also recommended.

Development of Semi-Automatic Welding Apparatus.—The semi-automatic welding machine developed at the Station was designed to simplify the task of tube welding and to permit the production of consistently sound joints without the employment of specially trained operators.

The apparatus is capable of handling all joints which may be welded in the horizontal.

The schematic arrangement of the apparatus is shown in Fig. 25.

The principle of operation is as follows:

The electrode carriers are connected to a solenoid which travels on an inclined, forced path. The cylindrical guide of the solenoid carriage is a part of a closed hydraulic system. The piston inside the cylinder is magnetically coupled to the solenoid carriage. Thus the fluid under the piston is under a pressure which corresponds to the combined weight of the piston and the solenoid carriage. The rate of escape of the fluid under the piston is regulated by the quick-acting throttle valve located at the bottom of the cylinder and this constitutes the control of the arc length. The incremental length is regulatable by changing the angle of inclination of the cylinder. The solenoid carriage carries two electrode holders, one on either side set at 180° from one another. Upon the completion of the travel, i.e., on depositing an electrode the entire frame is rotated 180°, whereupon the electrode carriage is again in the top position and the second electrode holder is ready to receive a fresh electrode.

The joint design developed in connection with the automatic welder permits a faster rate of production than obtainable by manual welding in so far that the volume of weld metal deposited in these joints is only $^2/_3$ of that required by the designs applicable to manual welding.

The macrographs, Fig. 26, show sections of 4, 6 and 8-inch I.P.S. tube joints welded by the automatic welder and Fig. 27 shows the appearance of the finished weld.

SUMMARY

The results of the investigation indicate the following:

1. *Thin-Wall Tubing.*—(*a*) The efficiency of welded joints in thin-wall tubing cannot be readily established only on the basis of static tension tests.

(*b*) The results of the dynamic test showed that sleeve type joints possessed the best joint efficiency.

(*c*) The results of the test for the flow resistance offered by inserts showed that non-streamlined inserts constitute an impediment in small diameter lines and that the cumulative value of the impediments is high.

(*d*) The results of the investigation showed that oxy-acetylene welding is preferable in the fabrication of small diameter pipe lines.

(*e*) The results of the dynamic tests showed that local stress relieving of welded small-diameter tube joints does not materially improve their efficiency but that it appears to secure a more consistent performance.

2. *Heavy-Wall Tubing.*—(*a*) The results of the investigation showed that the development of sound weld metal at the root zone is a major function of the joint design, and that neither manipulation nor technique appears to compensate for lack of root spacing.

(*b*) The investigation further showed that using electric arc welding the soundest weld metal is deposited when each increment is deposited maintaining the longest current dwell applicable without undercutting.

(*c*) It was further disclosed that moderate preheating promotes the development of sound weld metal and that it tends to lessen the difficulties of the task of tube welding in positions other than in the horizontal, rotated.

(*d*) From the results of the investigation, it becomes evident that assembling tube joints by tack welding is not a reliable method to develop sound weld metal throughout the entire root zone, and that the development of sound root conditions is substantially promoted by the use of suitable clamps.

(*e*) The results of the investigation showed that residual stresses in welded tube joints are at least two-dimensioned and that the value of either or both components may, under the circumstances, equal or exceed the design stresses. It became further evident that several methods may be applied to reduce the value of the residual stresses to negligible quantities. It appears that the most reliable method for local stress relieving is by induction heating.

3. *Inspection Tests.*—(*a*) *Qualification Tests.*—(1) The Station's experience indicates that process qualification tests for tube welding should be performed with a view to obtain information of the soundness of the weld metal and, therefore, equal weight shall be given to the results of physical tests and the disclosures of the visual examination of the macro-etched specimens representing at least each quarter of the joint.

(*b*) *Welders Qualification Tests.* (1) It is apparent from the above that in order to obtain the most information from this test the examination of macro-etched weld samples shall supplement the results of the mandatory physical tests.

4. *Non-Destructive Tests.*—(*a*) The test results obtained at the Station do not indicate the suitability of the magnetic powder method for welded joints inspected without machining off the reinforcement.

(*b*) The Station has had insufficient data on the use of X-ography in the field for the inspection of welded tube joints.

(*c*) The results of the test evaluating Gamma-ray examination of welded tube joints proved this method unsatisfactory for this purpose.

(*d*) The use of the Arcronograph method of inspection was found to be valuable both for training welders and as a means for field inspection in course of production.

The results of the test of the tube joints produced by the use of the semi-automatic welder indicate that the employment of apparatus of this type tends to promote the production of uniformly sound welds, and that for its operation welders of average ability may be employed without special training in tube welding. The tests further showed that by virtue of the joint design applicable to automatic welding a faster rate of production is indicated for joints welded by means of the automatic welding apparatus.

Discussion—Codes for Welded Pressure Vessels*

By J. G. Adair†

EDITORIAL NOTE: A member present said his company had not been allowed to do certain welding on a locomotive boiler and asked why the A. S. M. E. Boiler Code Committee did not endeavor to persuade the Interstate Commerce Commission to adopt its rules for the welding of locomotive boilers.

Dr. Jacobus said that the best of friendship existed between the two organizations and that fusion welding was being sanctioned to a greater and greater extent by the Interstate Commerce Commission. Permission to build a welded locomotive boiler was granted by the Commission to the Delaware & Hudson Railroad, which is being tried out under service conditions. He felt sure that eventually the Interstate Commerce Commission rules would be brought more completely in line with those of the A. S. M. E., which in turn are those of the AMERICAN WELDING SOCIETY.

Dr. Jacobus said it should be borne in mind that the A. S. M. E. Code prohibits the use of fusion welding where bending stresses are brought directly upon the welded joints. He drew a sketch on the blackboard to show a construction which had led to trouble in the early days. The water legs of box header boilers built in Germany were closed by means of strips of metal extending around the headers, the strips being fusion welded at their edges to the front and rear sheets of the headers. The movement of the inner sheets of the headers back and forth, due to the heating and cooling action of the furnaces, caused the fusion-welded joints to be subjected to bending stresses and led to the explosions of a number of large boilers with disastrous results. The explosions occurred in 1912 to 1916, which was before the use of ductile fusion welds, but the present fusion-welding codes contain the provision that bending stresses shall not be brought directly upon a welded joint, even though more ductile welding is now employed than in the boilers which exploded.

IN answer to the above remarks it is apparent that the discusser has some misunderstanding with respect to the requirements of the locomotive inspection law and the regulations that code authorities have found it necessary to follow in the construction and repair of fusion-welded boilers and parts thereof. None of the codes and none of the regulatory authorities, so far as I know, cast any reflection on the value of fusion welding, but they do attempt to suppress the taking of short cuts that give no consideration to the locations of the welds, or the quality thereof, and other factors that have been found to be necessary to secure continued safety.

* Paper presented by Dr. D. S. Jacobus, at the Twenty-first Annual Meeting of the AMERICAN WELDING SOCIETY, Cleveland, Ohio, October 24, 1940. Published in Oct. 1940 issue, THE WELDING JOURNAL.

† Mechanical Engineer, Bureau of Locomotive Inspection, Interstate Commerce Commission.

The locomotive inspection law specifically prohibits any railroad from using any locomotive that is not in condition to operate without unnecessary peril to life or limb and places the responsibility on the Director of the Bureau, who is in charge of enforcement, of seeing that this and other provisions are carried out. This provision obviously prohibits the use of assemblages that are less safe than conventional constructions.

It would appear that the remark was based on a recent occurrence where in acquiescence was sought and not given for the joining of the roof sheet and the outer firebox side sheets by fusion welding and some other welding that is not authorized by any boiler code. The location of the joints of the roof and side sheets is in the zone of greatest distortion or flexure, it having been shown by recent measurements that the movement from normal width exceeds one-half inch under hydrostatic pressure equal to the working pressure, but not under working temperature, and that some movement is continually taking place. Dr. Jacobus has just shown and explained the necessity of avoiding welds in locations subject to stresses that are caused by distortions.

I shall not take up your time by discussing the other features involved but it would appear to me to be rather out of order to appeal to the Chairman of the A. S. M. E. Boiler Code Committee, whose codes are practically standard not only in this country but also in other parts of the world, to work on the authority having charge of the enforcement of the locomotive inspection law with a view to having him sanction the use of non-radiographed non-stress-relieved welded joints in locations that are subjected to major distortions since such construction would be in direct violation of the requirements set up by his committee.

If the federal law establishing jurisdiction over the safety of locomotives should be repealed jurisdiction would automatically and immediately revert to the states and other political jurisdictions. We make no claim that the effect of our work over the past approximately 25 years, during which time locomotive boiler accidents that resulted in deaths or serious injuries were reduced 95 per cent, would thereby disappear because the state inspection services, the railroad employees and the public would eventually take care of that feature. Under these conditions, however, it would be found that welding on locomotive boilers would be under closer control than it is at present, and those affected would be forced to the conclusion that the locomotive inspection law had been rather liberal in the matter of use of welding, probably unduly so if the rigorous service to which these boilers are subjected is taken into consideration.

Sanction of the use of the welded locomotive boiler referred to by Dr. Jacobus was obtained by the owning and using railroad through a provision of the law whereby a railroad may change its rules provided the proposed changes are approved. This railroad filed an application for experimental use, for a five-year period, of a welded locomotive boiler and submitted a complete specification which generally conformed to the A. S. M. E. code, and changes in its rules for inspection and repair of this particular boiler, all in accordance with the provision previously referred to; this is the only application concerning a welded boiler that has ever been received that conformed to the plain requirements set up in the law, and consequently it is the only one that could thus far be authorized. I might also add that it was specifically stated in the application of the railroad, which was agreed to by the Mechanical Division of the Association of American Railroads, that no more applications to use boilers of this construction would be made until after the expiration of the five-year period.

In conclusion, and departing somewhat from the question that brought me to the floor, we of the Bureau of Locomotive Inspection cannot too highly commend the activities of Dr. Jacobus and his coworkers in the A. S. M. E. Boiler Code Committee. Their thorough consideration of all proposals, the weeding out of the unfit, their adoption of safe practices with minimum of expense to boiler manufacturers and users, and their willingness to help others with somewhat similar problems are outstanding examples of unselfish cooperation.

Welding Builds New Gasoline Plant in New Mexico

By A. F. Davis*

THE natural gasoline plant of the El Paso Natural Gas Company–Phillips Petroleum Company, located approximately six miles from Jal, New Mexico, which was recently placed in operation, was made possible by electric arc welding. The electric arc was used in construction of all pipe lines, the piping system, headers, compressors and other structural parts of the new plant.

The new plant is of the low-pressure absorption type, built to a thoroughly modern design and embodying several advanced features in processing equipment. It is to be operated in processing casinghead gas by the El Paso Natural Gas Company for its own needs and also for the Phillips Petroleum Company.

Designed for handling 85 million cubic feet of gas

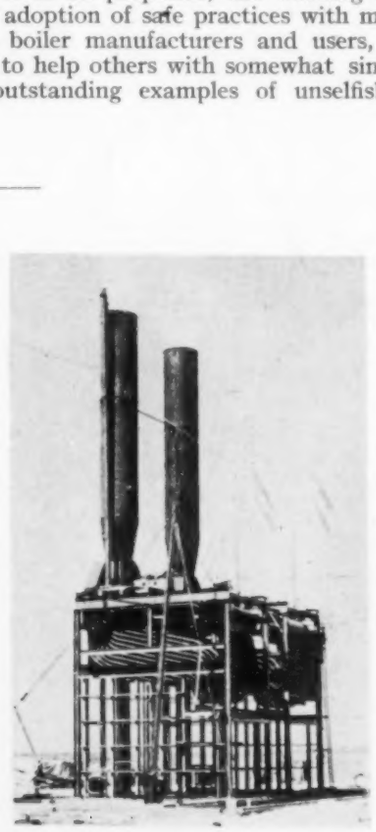


Fig. 1—Part of the New Gasoline Plant of the El Paso Natural Gas Co., Near Jal, New Mexico. All Piping Is Arc Welded

* Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

Fig. 2—An 18-Inch Arc-Welded Discharge Header in the New El Paso Plant

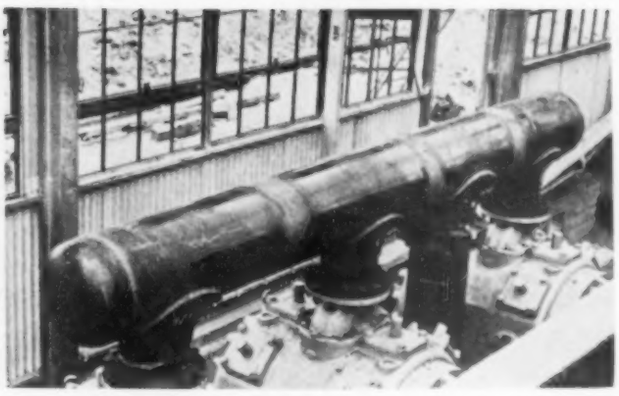
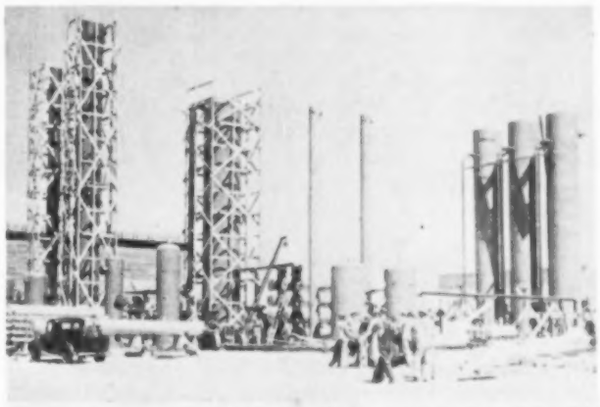


Fig. 3—A Suction Header of 16-Inch Pipe Arc-Welded with 10-Inch Branch Connections

Fig. 4—Part of the New El Paso Plant During Construction



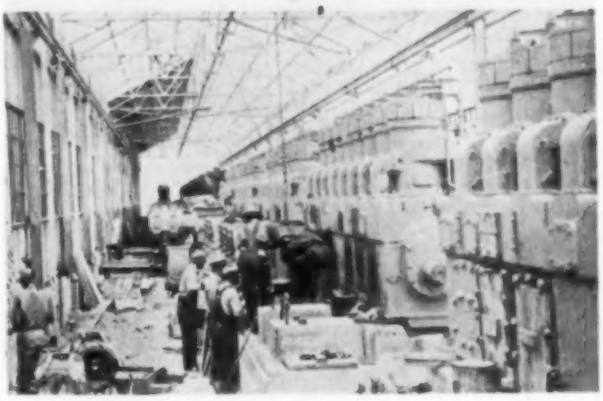


Fig. 5—A Battery of Compressors Being Installed in the New El Paso Gasoline Plant

daily, the plant contains the following integral units: a 10,200 hp. main compressor station, of which 9000 hp. are used in first-station compression and 1200 hp. for boosting pressure from 70 to 550 lb. gage of some of the residue gas; 1050 kw. power plant; 1020 hp. boiler unit; a water treating plant; absorption, distillation, stabilization and auxiliary equipment for producing butanes and various grades of natural gasoline.

Incoming wet gas is led to the plant through 65 miles of arc-welded field lines varying in size from 4 inches to 30 inches in diameter. The main arc-welded lines, consisting of one 30-inch sour gas line and one 26-inch sweet gas line, unite in the yard to form a header which is also arc welded.

The 65 miles of gathering lines were welded by the "stove pipe" method in which every joint is welded individually in three beads.

The high-pressure pipe line which carries sweet gas boosted to 550 lb. pressure, is of all welded construction. The wall thickness is $^{9}/_{16}$ inch and each joint was welded in seven beads; the first bead with $^{5}/_{32}$-inch electrodes and the other six with $^{3}/_{16}$-inch. All welds were made in downhand position.

Typical views of some of the welded parts of this plant accompany this article. Figure 1 shows part of the steam plant in which all pipe lines were arc welded. In Fig. 2 can be seen an 18-inch discharge header of all welded construction. In fabricating these headers they were bolted together to maintain alignment during welding. The equipment shown in Fig. 3 is a welded suction header of 16-inch pipe with 10-inch branch connections. Figure 4 is a general view of a portion of the plant during construction. A line-up of compressors being installed in the plant can be seen in Fig. 5.

Construction of the new plant was carried out entirely by personnel of the El Paso Natural Gas Company. The compressor station, auxiliary power plant, boiler plant and water treating plant, together with all piping was designed by El Paso engineers. Parkhill-Wade of Los Angeles designed the absorption, stripping and distillation facilities as well as other portions of the gasoline and butane recovery system while the Stearns-Roger Manufacturing Company of Denver did the fabricating.

BOUND VOLUME JOURNAL

The AMERICAN WELDING SOCIETY has made arrangements for members who wish to have their Journals for 1940 bound in attractive, imitation black leather covers, to do so by sending copies of the twelve issues to Russell-Rutter Company, Thirty-Third Street and Eighth Avenue, New York, N. Y., Att. Mr. Russell Lauben, Jr. A special reduced rate has been arranged at $1.75 per volume providing the issues of the JOURNAL are sent to the binder on or before February 10th. The bill for the binding and return postage will be sent direct from the Society's office.

Electro-Magnetic Stirring Action in a Spotweld*

By A. M. Unger,† H. A. Matis,‡ and W. A. Knocke§

THERE has been considerable discussion of the manner in which a spotweld is made. Some authorities have maintained that the metals being joined were heated to the plastic stage and then forged together by the pressure exerted by the spotwelding electrodes; others have maintained that there was an actual melting of the two metals, which, upon cooling, joined together in a cast structure. In this article we will present evidence of welds made by both methods, in the same materials, and the effect on strength of the weld by these two methods.

Welds Made by Melting

When the metal in a spotweld becomes molten, the welding current is carried by a liquid conductor in that part of the circuit that forms the weld. Electromagnetic forces act on this liquid conductor and create a violent stirring action. Photomacrographs have been made of various stages of this stirring action and will be presented in this article as evidence of the melting and mixing of the metal from the two sheets of metal being spotwelded together.

In order to understand the action of the current and magnetic field on the liquid conductor, we will briefly review a few fundamentals on motor action of a conductor carrying electric current in a magnetic field. The first fundamental is known as Fleming's Left-hand rule and can be found in any good book on direct-current motors. The relation among the direction of a magnetic field, the direction of a current in that field and the direction of the resulting motion of the conductor can be determined by this rule. Briefly stated, the rule is as follows:

"Point the forefinger in the direction of the field or flux, and the middle finger in the direction of the current in the conductor. The thumb will then point in the direction in which the conductor tends to move." This is illustrated in Fig. 1.

Motor action of this type is familiar to all users of portable spotwelders. Each time a weld is made, there is a very strong force in evidence, tending to separate the two secondary conductors that carry the welding current from the welder transformer to the portable gun. This is shown in Fig. 2. *A* and *B* are the two conductors. The current in *A* is traveling away from the reader into the sheet of paper. The flux lines due to the current in Conductor *B*, that cross *A*, are illustrated. Applying Fleming's Left-hand rule, we see that the motion is in a direction so as to separate the two conductors. Applying Fleming's Left-hand rule again, we find that there is also an equal and opposite force acting on Conductor *B* due

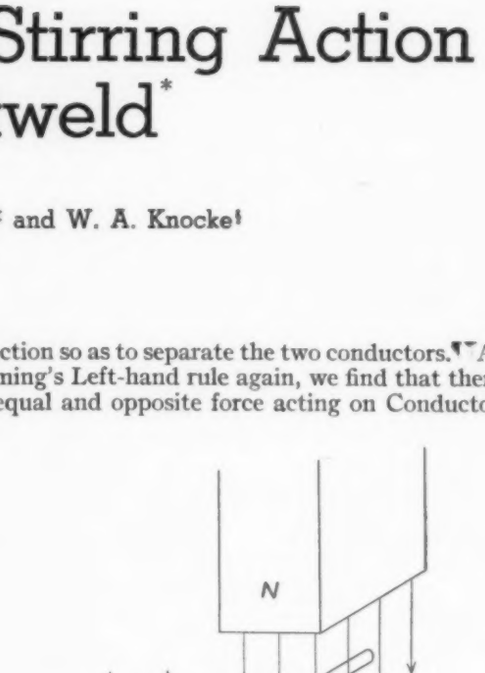


FIG 1
FLEMING'S LEFT-HAND RULE

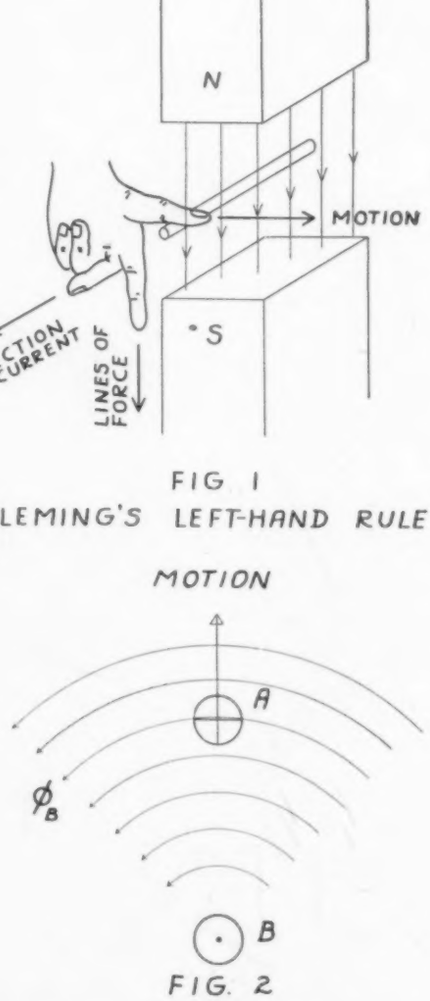


FIG. 2

ILLUSTRATING REPELLING FORCE BETWEEN TWO CONDUCTORS CARRYING CURRENT IN THE OPPOSITE DIRECTION.

ϕ_B = MAGNETIC FLUX DUE TO CURRENT IN CONDUCTOR B.

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to its current and the flux produced by current in Conductor A.

Figure 3 illustrates the path of current through a spotweld. This current is surrounded by a magnetic field produced by the current. Figure 4 is a cross section of this current path through the weld. The section can be assumed to be made of an infinite number of parallel filaments of current conductors. There are magnetic flux lines throughout this cross section, as illustrated. All of the flux produced by filaments of current P_1, P_2, P_3 and P_4 are outside the circle on which they are located. However, these filaments are intersected by flux lines produced by the current filaments inside the circle, as for example, P_5 and P_6. Applying Fleming's Left-hand rule to these filaments of current, we see that the motion in all cases is toward the center of the conductor. That such motion will actually take place in a liquid conductor is beautifully illustrated by an experiment made by Dr. E. F. Northrup and described in his article, "Some Newly Observed Manifestations of Forces in the Interior of an Electric Conductor," published in *Physical Review*, XXIV, No. 6, 474 (June 1907).

Figure 5 shows the set-up made in Dr. Northrup's experiment. T and t are fiber tubes, t having an inside diameter of one inch. B and D are brass plugs tightly fitted in the ends of the inside tube. Heavy copper terminals enable these plugs to be connected to a source of large current capacity. At the center of the tube is placed a fiber ring.

Through the sides of the tube and fiber ring several small holes, h, were drilled radially to the axis. The bottom of the annular space between the tubes, T and t, was closed by a fiber piece, P. The two tubes were then filled with mercury to the level shown in the cut. Current is carried by this liquid column of mercury. The inward motion of the current filaments creates a pressure at the center of the column greater than that at the outside. This causes the mercury to rise from the tube, through outlet H, run into the outer chamber, and return to the conducting tube through the holes, h, drilled at the midway point. This experiment demonstrates the movement of a liquid conductor by electro-magnetic forces.

Figure 6 shows a section through a spotweld illustrating how stirring action of this same nature takes place in the weld when the metal is molten. The direction of movement of the liquid conductor is toward the center, as illustrated in Fig. 4. As the direction of movement is all toward the center, the liquid pressure is greatest at the center and this creates a movement at the center, parallel

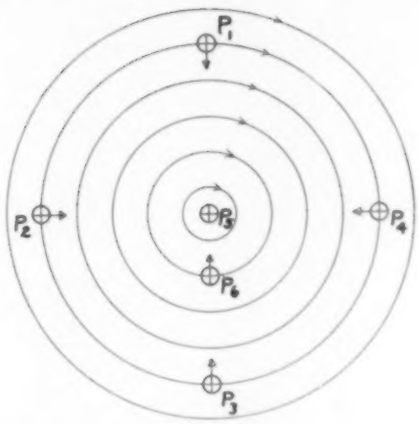


FIG. 4

ILLUSTRATING DIRECTION OF MOTOR ACTION ON VARIOUS FILAMENTS OF CURRENT IN THE CROSS-SECTION OF AN ELECTRIC CONDUCTOR OR THE CROSS-SECTION OF A SPOT-WELD. ARROWS ON EACH FILAMENT INDICATE DIRECTION OF MOTION CONDUCTOR WILL TAKE IF FREE TO MOVE.

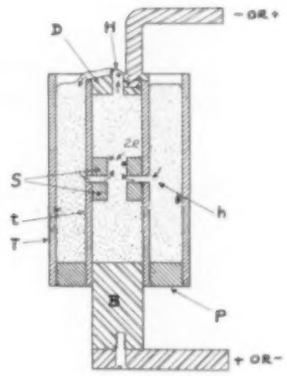


FIG. 5

DR. NORTHRUP'S EXPERIMENTAL SETUP TO SHOW MOVEMENT OF A LIQUID CONDUCTOR WHEN CARRYING ELECTRIC CURRENT.

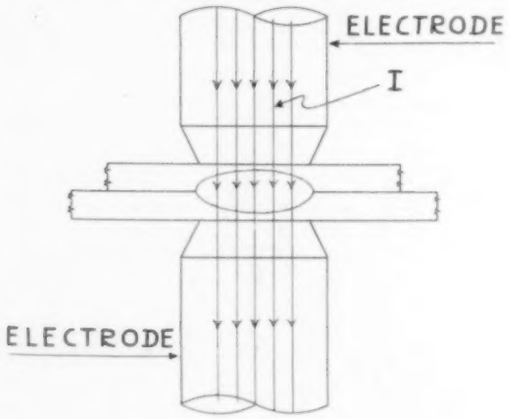


FIG. 3

PATH OF CURRENT THROUGH A SPOTWELD.

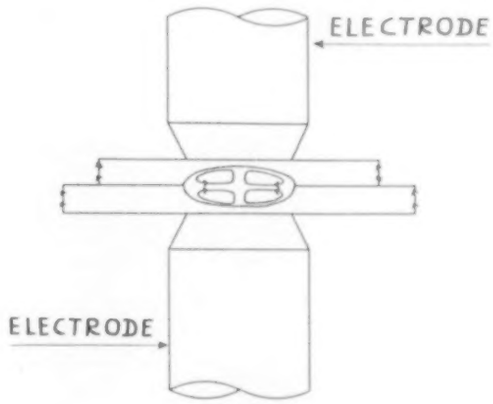


FIG. 6

STIRRING ACTION OF MOLTEN METAL IN A SPOTWELD.

to the axis of the weld in both directions, tending to lengthen it, similar to the experiment with the mercury conductor illustrated in Fig. 5. As the weld is confined by solid metal on all sides, the molten pool cannot lengthen. The direction of movement from the axis of the weld is around the circumference to the mid-point. Here the flow is inward, toward the axis, completing the circuit. This stirring action will continue as long as the electric current is maintained. The direction of stirring is the same when the current reverses, because the magnetic field also reverses in direction. To demonstrate this stirring action, a set of experiments was conducted.

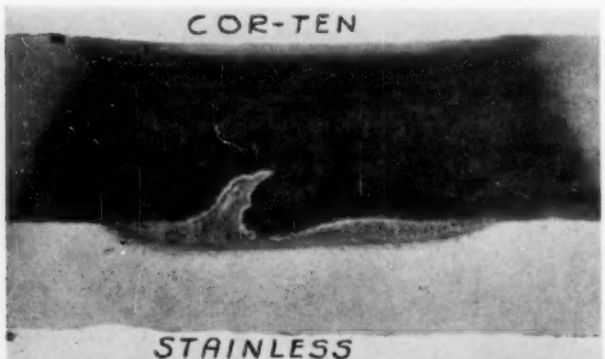
For these experiments, two dissimilar metals were chosen—a low-alloy high-tensile steel called Cor-ten, and 18–8 stainless steel. Stainless steel was selected because it etched differently from the Cor-ten and showed the migration of one metal into the other.

This combination also represents a typical use of the two metals. The low-alloy high-tensile steel is used for the framework of a structure, and the stainless steel is used to cover the structure. The thicknesses of the two metals used were 11 gage (0.125 inch) for the Cor-ten, and 14 gage (0.0766 inch) for the stainless. Welds were made with a domed electrode against the Cor-ten, and a flat electrode against the stainless steel. The purpose of the flat electrode was to reduce to a minimum the marking on the stainless side so that welds made could be used on a finished surface.

Welds were made with a variety of timings (durations of welding current) in order to illustrate the various stages of the stirring and mixing action. These samples were examined by cutting a section through the weld, polishing and etching.

The etched samples give positive evidence of melting by showing the migration of the stainless steel into the Cor-ten. An early stage of this transfer of metal is shown in Fig. 7. This sample has been etched electrolytically in a chromic acid solution. The penetration of the weld into either the stainless or Cor-ten is very shallow, but the migration of one metal into the other has already begun.

Fig. 7—10X. Electrolytic Etch in Chromic Acid



A little further advanced stage of the migration of the two metals is shown in Fig. 8. This photograph is a 20-diameter enlargement and does not show the entire weld. Only the swirls of stainless in the Cor-ten steel are shown. A nital etch was used to show the greatest contrast between the stainless and the Cor-ten. By comparing Fig. 8 with Fig. 6, the direction of motion of the stirring action can be followed. As a considerable portion of the time required to make the weld is consumed in bringing the metal up to melting temperature, the stirring force must be high in magnitude to mix so rapidly.

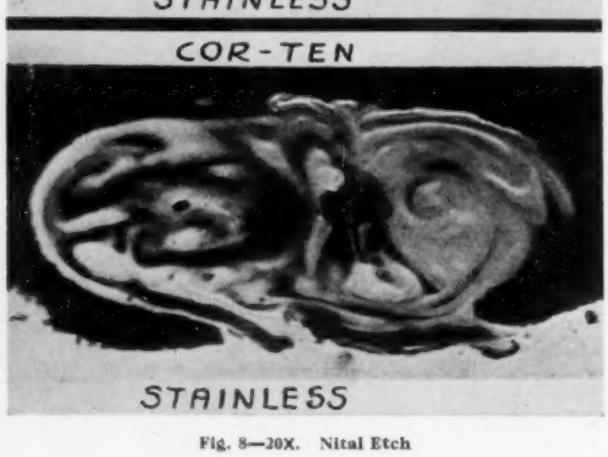


Fig. 8—20X. Nital Etch

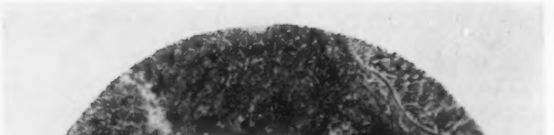


Fig. 9—100X. Electrolytic Etch in Chromic Acid

Figure 9 is a 100-diameter photomicrograph of one of the stainless swirls in the Cor-ten. The etch was electrolytic in chromic acid. The stainless streamer is shown to have been molten by the dendritic structure of the stainless.

Figure 10 shows a completed weld. There has been a thorough mixing of the two metals in the weld. The weld metal is an alloy consisting of an average of the chemical elements from the volume of the Cor-ten melted and the volume of the stainless steel melted. In the weld shown, the average resulted in a chrome alloy that is very definitely martensitic in character. The weld is hard and brittle. Notice the cracks shown in the section of this weld, Fig. 10. Other samples that were cut through were cracked much more. The cracks traveled in from the juncture of the two sheets and then took a right angle turn to the outside surface of the sheet. When a chisel was driven in between spotwelds, they snapped loose with very little effort. Metal pulled out of the Cor-ten to about one-half the depth of penetration of the weld into the Cor-ten (Fig. 19).

Hardness readings made on a section through the weld are given in Fig. 13. Note the great increase in hardness in the weld metal. The readings were taken with a Rockwell hardness testing machine on the "B" and "C" scales but have been converted to the Brinell scale for a direct comparison between the two. A weld of this type is not very reliable as it is weak in impact and fatigue strength.

Welds Made Without Melting

As the welds made by melting and mixing of the metals were unsatisfactory, a procedure was developed for making the welds without mixing. Advantage was taken of the fact that stainless steel has a lower heat conductivity than the Cor-ten. A satisfactory weld was made with the use of an interrupter timer. The timing finally selected was 3 "shots" of current on, for a duration of 5 cycles, with a 20-cycle cooling period between the "shots" of welding current. The stainless steel in this manner was brought up to temperature ahead of the Cor-ten. It was then only necessary to raise the temperature of the Cor-ten to the plastic stage in order to make the weld. A weld of this type is shown in Fig. 11. There has been no migration of the one metal into the other. The bond between the two metals is shown in Fig. 12. This is a 100 diameter photomicrograph. The

Fig. 10—10X. Nital Etch Plus Electrolytic Etch in Chromic Acid

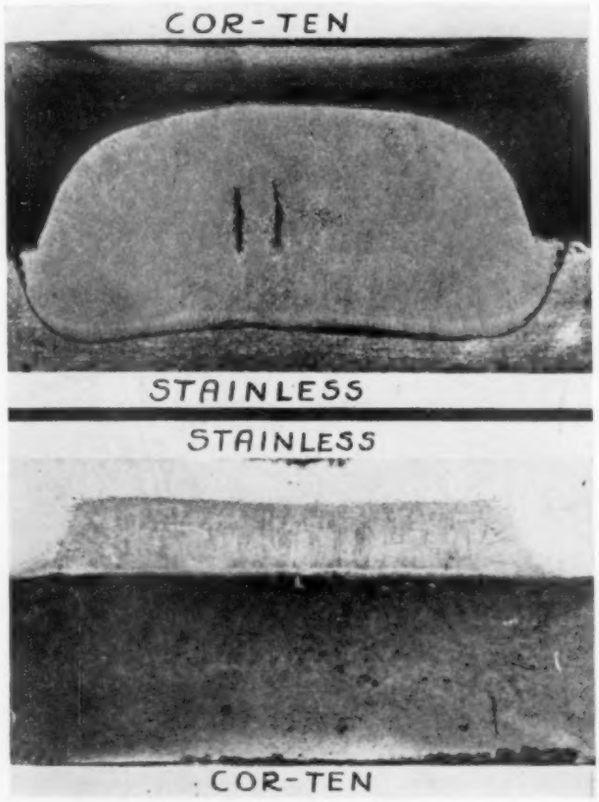


Fig. 11—10X. Nital Etch Plus Electrolytic Etch in Chromic Acid

sample was first etched with nital solution and then etched electrolytically in chromic acid. The structure of the Cor-ten is still the original structure. The weld has been made while the Cor-ten was in a plastic condition. This prevented movement of the metal, as was the case when the Cor-ten was molten, previously described.

Hardness readings made on a section through the weld are given in Fig. 14. These were also made with a Rockwell machine but converted to Brinell. Note the much lower values than those shown in Fig. 13. There has only been the customary increase in hardness and the weld is in a satisfactory condition.

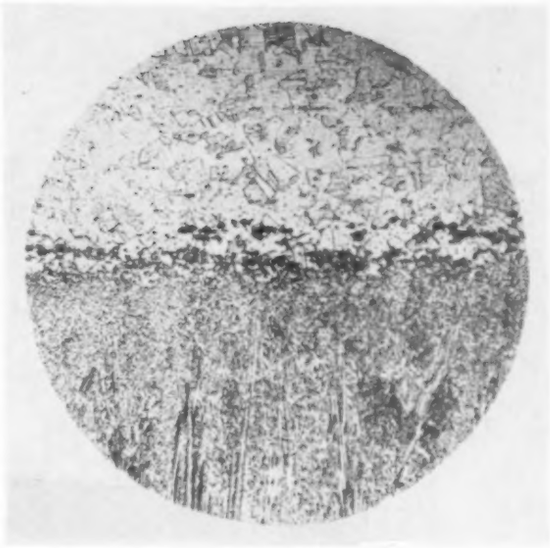


Fig. 12—100X. Nital Etch Plus Electrolytic Etch in Chromic Acid. (Top) Cor-Ten. (Bottom) Stainless

Physical Properties of the Two Types of Welds

In order to demonstrate the difference in strength of welds made by the two methods, with the two materials chosen, standard shear and U-tensile specimens were made with varying currents covering the range of minimum to maximum current for the timing, pressure and electrode tip size used.

A standard shear test consists of two overlapped pieces 2 inches wide, welded together with a single spot and tested by pulling apart in a tensile-testing machine. The specimen is illustrated in Fig. 15. The strength of the specimen is recorded as the ultimate load required to tear apart the two pieces.

The U-tensile specimen consists of two channel sections 2 inches wide, 2 inches long and 2 inches high. These two channels are welded together back to back with a single spot. Figure 16 illustrates this type of specimen. The channels are bolted to inserts placed in each channel. These inserts are then gripped in the jaws of a tensile-testing machine and the ultimate load recorded as the U-tensile strength of the weld. The ratio of U-tensile strength per shear strength is a measure of the ductility of the weld.

The curves in Fig. 17 give the shear and U-tensile values for two different procedures, "A" and "B." Procedure "A" was current on for 20 cycles. Procedure "B" was for current on for 3 "shots" of 5 cycles each, with 20 cycles cooling time in between each "shot." Current was varied from the minimum current that would weld, to the maximum permissible. Electrode pressure was kept constant at 2500 lbs. for the entire test. The electrode tips used were a flat electrode, $^7/_8$ inch in diameter

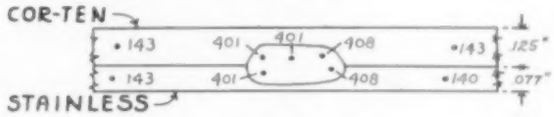


FIG. 13

HARDNESS READINGS IN WELD WHERE THE TWO METALS HAVE MIXED TOGETHER (ALL VALUES IN BRINELL)

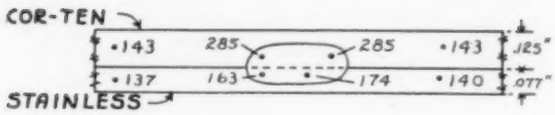


FIG. 14

HARDNESS READINGS IN WELD WHERE THE TWO METALS HAVE NOT MIXED TOGETHER (ALL VALUES IN BRINELL)

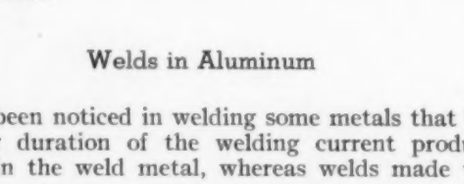
against the stainless steel surface, and a domed electrode with $3\frac{1}{2}$-inch radius, $\frac{7}{8}$-inch diameter against the Corten steel.

The curves show the higher shear and U-tensile strength values obtainable with procedure "B," that is, with the procedure that welds without mixing the two metals. Much better values are especially obtained for the U-tensile strength. A wider range is also available in which good welds can be made.

In Fig. 18 the ratio of U-tensile strength to shear strength is plotted. This is a good test of the ductility of the weld. Much higher values are obtained for procedure "B," showing its greater ductility over the welds made with procedure "A." An examination of the welds made after testing also gave visual evidence of the difference in ductility. The welds made with procedure "A" had large, coarse crystals in the fracture. Shrink cracks and porosity were greatly in evidence. Welds made with procedure "B" had a fine-grained structure in the fracture, with no evidence of shrink cracks or porosity. Figure 19 shows a photograph of the fracture of both types of welds.

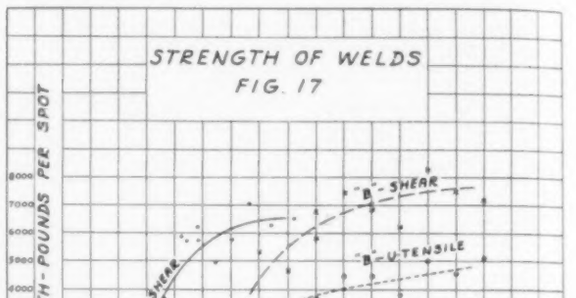
Welds in Aluminum

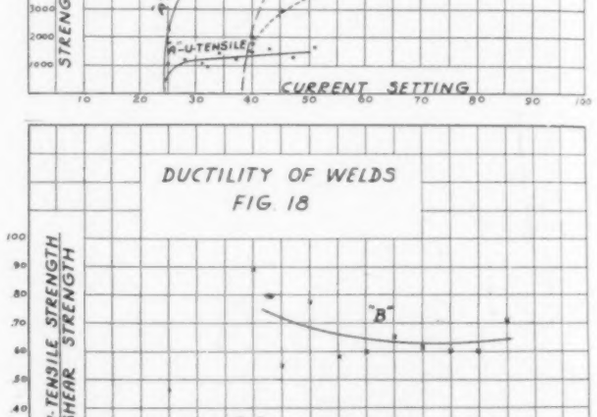
It has been noticed in welding some metals that long timing or duration of the welding current produced porosity in the weld metal, whereas welds made with short timing showed no evidence of porosity. It is the opinion of the authors that the long timing meant making the weld by melting of the metal and hence a stirring action in the metal. This violent stirring action releases gas absorbed in the metal and creates porosity. When the molten metal is high enough in temperature, metal vapors may also cause porosity. Welds made with short timing are made by bringing the metal to a plastic temperature, hence no violent stirring of the metal and no release of gas. An example of this is welds made in aluminum with alternating current, for the first type of weld, and with a quick discharge of current, as is the case with the stored energy type of spotwelding machine, for the second type. It has been demonstrated that welds made in aluminum with the stored energy machines are freer from porosity and cracks.



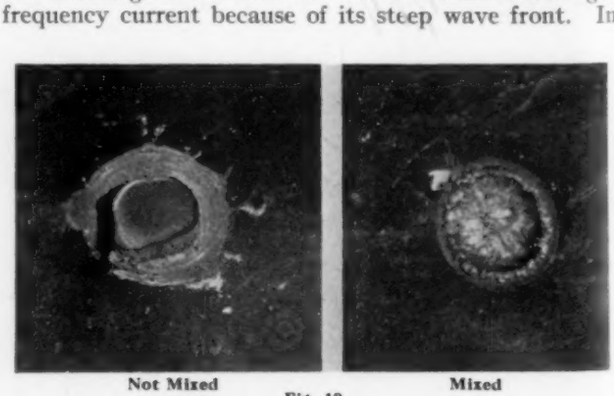
SHEAR TEST SPECIMEN
FIG. 15

U-TENSILE TEST SPECIMEN
FIG. 16





The quick discharge of the stored energy machine limits the time that the metal is at a high temperature, thereby preventing stirring or reducing it to a minimum. The discharge current can be considered similar to a high-frequency current because of its steep wave front. In



Not Mixed — Mixed

Fig. 19

induction furnaces it is a known fact that the stirring action is less with high-frequency current.

Welding Two Different Metals

When welding two different metals together, it is necessary to consider what type of alloy will result from a mixture of the two. If the result will be a brittle metal, as was the case with Cor-ten and 18-8 stainless, it will be necessary to develop a procedure of welding without mixing of the two metals. To do this, it will be necessary to make a series of samples with various timings (durations of welding current). These samples should be cut through for a cross section, polished and etched. Etching will show in which direction the timing of the weld should be adjusted to get the proper results, that is, weld without mixing of the two metals.

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Sections—CHAIRMEN, SECRETARIES AND REGULAR MEETING DATES

BIRMINGHAM **3rd Fri.**
CHAIRMAN—C. R. TINSLEY, U. S. Pipe & Foundry Co., Bessemer, Ala.
SECRETARY-TREAS.—W. L. POOLE, Air Reduction Sales Company, 2825 No. 29th Ave., Birmingham, Ala.

BOSTON **2nd Mon.**
CHAIRMAN—F. B. MEHAFFEY, Air Reduction Sales Co., 122 Mt. Vernon St., Upham Crs., Dorchester, Mass.
SECRETARY—P. N. RUGG, 8 Eastern Ave., Wakefield, Mass.

CANAL ZONE **First Tuesday**
CHAIRMAN—R. E. HOLLICK, Box 1146, Ancon, Canal Zone
SECRETARY-TREAS.—JAMES G. MURRAY, P. O. Box 623, Diablo Hts., Canal Zone

CHATTANOOGA, TENN. **1st Wed.**
CHAIRMAN—MARK HOLT, Chattanooga Welding & Machine Co., Chattanooga, Tenn.
SECRETARY—M. T. GLENN, 242 Oak Street, Chattanooga, Tenn.

CHICAGO **3rd Fri.**
CHAIRMAN—L. S. MCPHEE, Whiting Corp., Harvey, Ill.
SECRETARY—M. S. HENDRICKS, Welding Engineer, Room 731, 506 South Wabash Avenue

CINCINNATI, OHIO
CHAIRMAN—ERIC O'HARA, Cincinnati, Gas & Elect. Co., Cincinnati, Ohio
SECRETARY—R. G. FUGATE, Williams & Co., Inc., Cincinnati, Ohio

CLEVELAND **2nd Wed.**
CHAIRMAN—J. F. MAINE, Republic Structural Iron Works, Cleveland Ohio
SECRETARY-TREAS.—A. LESLIE PFEIL, Universal Power Corporation, Cleveland, Ohio

COLORADO **3rd Wed.**
CHAIRMAN—J. H. JOHNSON, Johnson Supply Co., Denver, Colo.
SECRETARY-TREAS.—H. W. CREAGER, Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

COLUMBUS, OHIO **2nd Fri.**
CHAIRMAN—J. A. FOUST, Ohio State University, Columbus, Ohio
SECRETARY—G. S. HERREN, The Seagrave Corp., Columbus, Ohio

CONNECTICUT **1st Tues.**
CHAIRMAN—J. S. MILLER, New York, New Haven & Hartford R. R., New Haven, Conn.
SECRETARY—B. H. PERRY, Hartford Elec. Steel Co., 540 Flatbush Ave., Hartford, Conn.

DETROIT **1st or 2nd Fri.**
CHAIRMAN—G. N. SIEGER, S. M. S. Corp., 1165 Harper Ave., Detroit, Mich.
SECRETARY—O. L. SMITH, Weldit Acetylene Co., 638 Bagley, Detroit, Mich.

GEORGIA **1st Fri.**
CHAIRMAN—D. B. HUNT, 484 Brentwood Dr. N. E., Atlanta, Ga.
SECRETARY—H. J. LEE, P. O. Box 4564, Atlanta, Ga.

HAWAII **Last Thurs.**
CHAIRMAN—ROBERT A. PLAUS, W. A. Ramsay, Ltd., Honolulu, T. H.
SECRETARY—ALAN G. SLIPPER, Hawaiian Gas Products Co., P. O. Box 2454, Honolulu, T. H

INDIANA
CHAIRMAN—WAYNE H. MCGLADE, J. D. Adams Mfg. Co., Indianapolis, Ind.
SECRETARY—E. F. GILVEAT, JR., J. D. Adams Mfg. Co., 217 So. Belmont Ave., Indianapolis, Ind.

KANSAS CITY, MO. **3rd Mon.**
CHAIRMAN—N. ASHTON, Ash, Howard, Needles & Tammen, Kansas City, Mo.
SECRETARY—GEORGE BAIN, Lincoln Electric Co., Kansas City, Mo.

LAKE SHORE
CHAIRMAN—A. W. WIEMANN, Armour Leather Co. Sheboygan, Wis.
SECRETARY—R. E. KING, 1308-A Hamilton St. Manitowoc, Wis.

LOS ANGELES **3rd Thurs.**
CHAIRMAN—C. W. ROBERTS, Southwestern Eng. Co., Los Angeles, Calif.
SECRETARY—E. O. WILLIAMS, Victor Equip. Co., Los Angeles, Calif.

LOUISIANA **1st Fri.**
New officers not yet selected.

MARYLAND **3rd Fri. except April**
CHAIRMAN—R. A. MANSFIELD, Southern Oxygen Co., Baltimore, Md.
SECRETARY-TREAS.—W. M. H. BALLATYNE, 1408 Lexington Bldg., Baltimore, Md.

MILWAUKEE **3rd. Fri.**
CHAIRMAN—R. E. BOECK, 3889 N. 4th St., Milwaukee, Wis.
SECRETARY—GILBERT F. MEYER, Machinery & Welder Corp., Milwaukee, Wis.

NEW YORK **2nd Tues. except when Joint Meeting is held**
CHAIRMAN—J. T. PHILLIPS, Foster Wheeler Corp., Carteret, N. J.
SECRETARY—WAYNE A. HOWARD, Socony-Vacuum Oil Corp., Brooklyn, N. Y.

NORTHWEST **3rd Wed.**
CHAIRMAN—T. P. HUGHES, University of Minn., Minneapolis, Minn.
SECRETARY—ALEXIS CASWELL, Manufacturers' Assoc. of Minn.,200 Builders Exchange Bldg., Minneapolis, Minn.

NORTHERN NEW JERSEY
CHAIRMAN—F. C. FYKE, Standard Oil Development Co., Elizabeth, N. J.
SECRETARY—H. S. CARD, 449 Elmora Ave., Elizabeth, N. J.

NORTHERN N. Y. **Last Thurs.**
CHAIRMAN—W. C. HUTCHINS, General Electric Co., Schenectady, N. Y.
SECRETARY—W. W. CHURCHILL, General Electric Co., Schenectady, N. Y.

OKLAHOMA CITY **1st Fri.**
CHAIRMAN—K. B. BANKS, P. O. Box 1377, Oklahoma City, Okla.
SECRETARY—F. SPREHE, Midwest Steel Co., Oklahoma City, Okla.

PEORIA—CENTRAL ILLINOIS
CHAIRMAN—E. E ISGREN, R. G. Le Tourneau, Inc., Peoria, Ill.
SECRETARY—ALBERT A LOSCH, R. G. Le Tourneau, Inc., Peoria, Ill.

PHILADELPHIA **3rd Mon.**
CHAIRMAN—H. W. LAWSON, 243 E. Church St., Bethlehem, Pa.
SECRETARY—H. E. HOPKINS, Arcos Corp., 401 N. Broad St., Phila., Pa.

PITTSBURGH **Middle Wed.**
CHAIRMAN—G. F. WOLFE, Dravo Corp., Engineering Wks. Div., Pittsburgh, Pa.
SECRETARY—J. F. MINNOTTE, Minnotte Bros., 1201 House Bldg., Pittsburgh

PUGET SOUND
CHAIRMAN—G. M. MCBRIDE, Air Reduction Sales Co., 3623 East Marginal Way, Seattle, Washington
SECRETARY-TREAS.—R. S. RUSSELL, Hydraulic Supply Co., 7500—8th Ave. South, Seattle, Wash.

QUAD CITIES
CHAIRMAN—A. R. GUSTAFSON, 840 Third Ave., Moline, Illinois
SECRETARY—J. W. SHUGARS, Lincoln Elec. Co., Moline, Illinois

ROCHESTER, N. Y. **1st Thurs.**
CHAIRMAN—FRED L. PEIFFER, 1029 Lyell Ave., Rochester, N. Y.
SECRETARY—PAUL W. JAMES, Lincoln Electric Co., 17 Lake View Park, Rochester, N. Y.

SAN FRANCISCO **Last Fri.**
CHAIRMAN—H. CHANEY, Bethlehem Steel Co., San Francisco, Calif.
SECRETARY—J. G. BOLLINGER, Air Reduction Sales, Park & Halleck Sts., Emeryville, Calif.

SAN JOAQUIN VALLEY
CHAIRMAN—G. D. ATMORE, 401 Santa Barbara St., Santa Paula, Calif.
SECRETARY—H. S. NIX, Taft Union H. S. & Jr. College, Box 1364, Taft, Calif.

ST. LOUIS **2nd Fri.**
CHAIRMAN—L. H. DODD, American Inst. of Steel Const., 1405 Paul Brown Bldg., St. Louis, Mo.
SECRETARY—M. B. SCIOLETICH, Combustion Engrg. Co., Heine Boiler Div., St. Louis, Mo.

SOUTH TEXAS
CHAIRMAN—B. W. FARQUHAR, Gulf Oil Corp., Port Arthur, Texas
SECRETARY—T. D. KETCHBAW, Industrial Welding & Testing Lab., Houston, Texas

TULSA, OKLAHOMA
CHAIRMAN—F. A. HOFFMAN, Tulsa Boiler & Mach. Co., Tulsa, Okla.
SECRETARY—JAMES B. DAVIS, Tulsa Testing Labs., Tulsa, Okla.

WASHINGTON, D. C. **2nd Tues.**
CHAIRMAN—C. A. TREXEL, Bureau of Yards and Docks, Navy Department, Washington, D. C.
SECRETARY—E. BROOKER, 129 South Buchanan St., Arlington, Va.

WESTERN NEW YORK **Last Mon.**
CHAIRMAN—G. M. TREFTS, III, Farrar & Trefts, Inc., Buffalo, N. Y.
SECRETARY—D. W. PATTERSON, Federal Mach. & Welder Co., Buffalo, N. Y.

WICHITA, KANSAS
CHAIRMAN—H. CHRISTOPHER, 1220 Blane St., Wichita, Kans.
SECRETARY-TREAS.—K. O. HOUSER, Kansas Gas & Electric Co., Wichita, Kansas

YORK—CENTRAL PENNA.
CHAIRMAN—E. J. BRADY, Alloy Rods Corp., 501 Prospect St., York, Penn.
SECRETARY—C. B. Herrick, 628 S. Pershing Ave., York, Pa.

YOUNGSTOWN (OHIO) **2nd Mon.**
CHAIRMAN—J. D. GORDON, Taylor-Winfield Corp., Warren, Ohio
SECRETARY-TREAS.—A. L. WILLIAMS, Federal Machine & Welder Co., Warren, Ohio

Welding Society

ACTIVITIES — Related Events

THE PRESIDENT'S LETTER

The Section Officers Conference, in its recent meeting during the annual convention at Cleveland, recommended the appointment of a Section Advisory Committee to act in an advisory capacity to the Board of Directors in all matters pertaining to the activities of the Sections and to be responsible for planning and conducting the Section Officers Conference.

The organization of the Section Advisory Committee, under the chairmanship of Mr. K. L. Hansen, was approved by the Executive Committee at its meeting of December 12th.

This modification of organization is one of the most important steps taken in recent years. The attention of the Executive Committee and of the Headquarter's Staff is necessarily given to matters of national interest. The organization and preparation of codes and standards, the publication of the JOURNAL, the organization of annual meetings and other technical activities of the SOCIETY are functions that can be performed only by the SOCIETY as a unit. Such work cannot be accomplished, however, without the cooperation and support of the individual members of the SOCIETY, nor can they be effective without a large representative membership.

The growth of the SOCIETY depends more upon the activity of the individual Sections than upon the work performed at headquarters. There are many who join the SOCIETY because of the headquarters work. The large majority, however, are members because Section activities meet their direct needs. The art and science of welding have developed rapidly. There are no complete and up-to-date books. These and other conditions favor the growth of sections, as through them members can keep in touch with current developments.

If the SOCIETY is to be of maximum usefulness for which a larger membership is essential, it must be highly sensitive to the needs and problems of the Sections and through them of the individual members. The permanent organization of the Section Advisory Committee furnishes a channel highly sensitive to these decentralized activities. It is to be hoped that the Sections and Districts will take advantage of the organization for a complete discussion of problems and the formulation of recommendations requiring action by the National Society. It is believed that the Chairman of this Advisory Committee will welcome Section officers taking the initiative in presenting their view-points.

WELD TEST CONTEST

"Do You Know Your Own* Strength?" (*Your own welded products.) That was the question asked visitors to the AMERICAN WELDING SOCIETY Booth at the National Metal Congress.

Evidently people do know the strength of welds because there were many correct answers returned, according to J. R. Morrill, Chairman of the SOCIETY Booth, member of the Cleveland Section, who recently announced the winners in the weld test contest sponsored by the AMERICAN WELDING SOCIETY.

Three mild steel test specimens, arc welded with an electrode of the A. W. S. E-6010 class were tested to failure and mounted so that Exposition visitors could examine them carefully and enter their estimate of the test values.

Winners of the *Welding Handbook* prize for guessing closest to the Free Bend specimen which gave a 56% elongation value when tested were: H. F. Brown, Cranford, N. J., and E. D. Deber, Wollaston, Mass.

The Procedure Handbook of Arc Welding Design and Practice, furnished by The Lincoln Electric Company, was awarded to the following winners who guessed closest to 68.5 ft.-lb. which was the test value of the Izod Impact specimen: John F. Cunningham, Jr., Saginaw, Mich.; G. Dolch, Cleveland, Ohio; C. P. Whitmire, Tulsa, Okla.; and D. D. McGarr, Tulsa, Okla.

Award was made of the *Welding Encyclopedia* furnished by the Welding Engineer Publishing Company, to George E. Knox of Washington, D. C., who guessed closest to 65,420 lb. per square inch, the tensile strength of the third weld test specimen.

WELDING HANDBOOK

The supply of the 1938 *Welding Handbook* having been exhausted several months ago, work has been started on the preparation of the 1941 edition to appear during the latter part of 1941. The Handbook Committee consists of: Messrs. D. S. Jacobus, *Chairman;* C. A. Adams, H. C. Boardman, W. F. Hess, C. W. Obert, W. Spraragen, Editor.

A list of chapters has been prepared and committees selected to prepare these chapters. Committees have now finished with the outline of their chapters. These are being correlated to prevent unnecessary duplication and to make sure that important gaps are filled. The book will be available free of charge to all members of the SOCIETY in the Sustaining and Member grades. Other members of the SOCIETY will be privileged to purchase their first copy of the book at $4.00. The price to non-members will be $6.00 in the United States and $6.50 elsewhere. All members of the SOCIETY will be privileged to buy additional copies at a special rate of $5.00.

SPECIAL COURSE ON WELDING

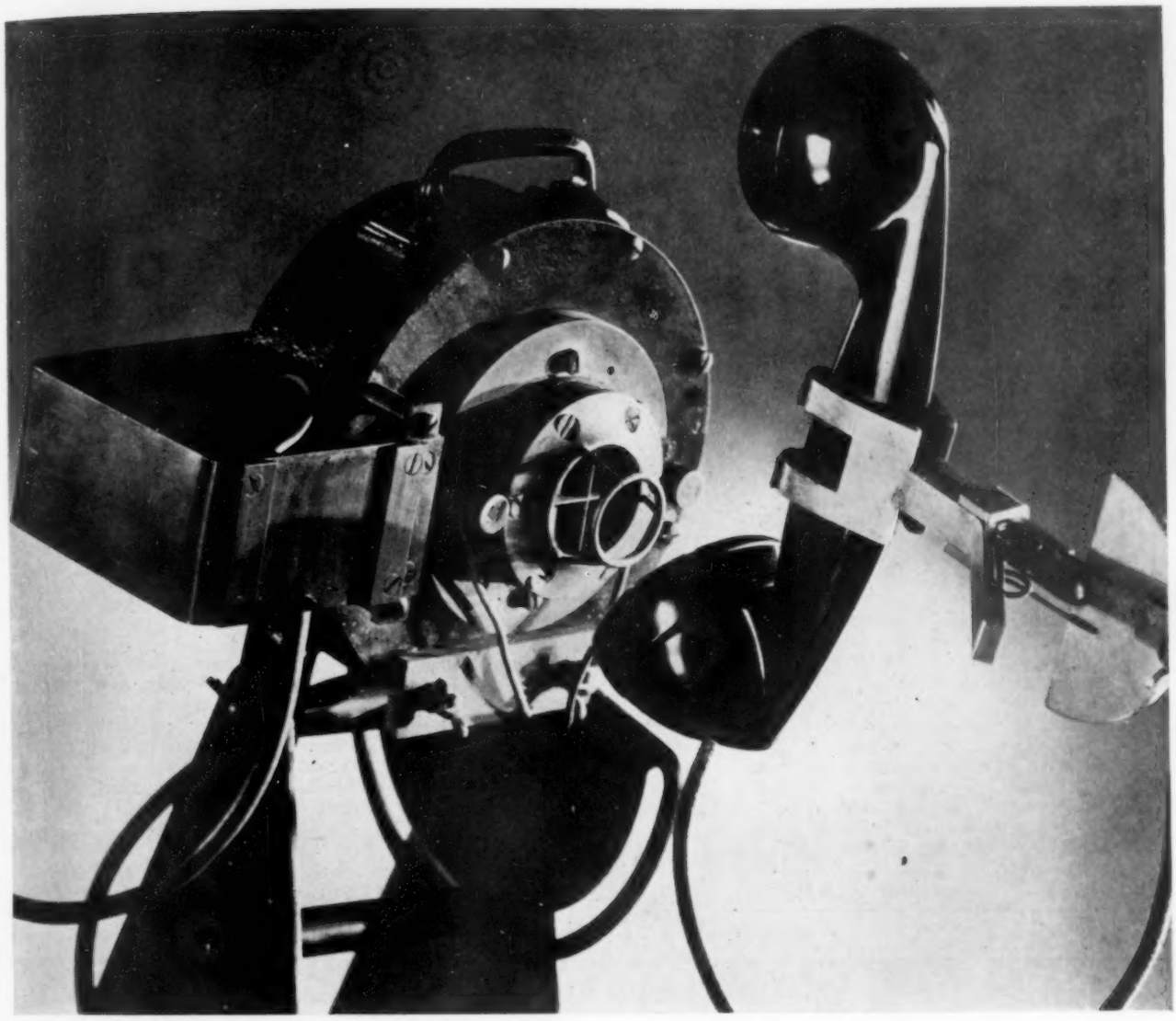
For the past two years the Rensselaer Polytechnic Institute has offered a special course in Welding Engineering for men in industry. Owing to the pressure placed upon business by the National Defense program, it is felt that the management will be reluctant to allow men to leave their employment for a period of four weeks to attend the course. The Welding Laboratory is also under considerable pressure due to the National Defense Research Program. The Institute has, therefore, decided not to offer this course during the present academic year.

MACHINE AND TOOL SHOW

Almost four months prior to the opening of the bi-annual Machine and Tool Progress Exhibition to be held March 25 to 29, 1941, in Detroit's big Convention Hall, more than three-fourths of the total available space is now reserved according to Ford R. Lamb, Executive Secretary, American Society of Tool Engineers, sponsors of the show. This is in spite of the addition of extra floor space a few weeks ago.

The 1941 show will be held in conjunction with the annual convention of the Tool Engineers' Society. Basic theme of both the exhibition and convention will be "Education for National Defense." The most modern production machines and tools available to industry will be shown. Exhibitors are being requested to have their machines, tools and equipment in actual operation wherever possible, so that their use can be studied by those visiting the show.

In addition to many types of metal removing machines and tools, the classification of exhibits includes air conditioning equipment for factories, alloy castings and die sections, blowers, conveyors, hoists, paints, oils and greases, pyrometers, pumps, welding units, wrenches and hand tools. Drafting materials, equipment for promoting plant safety, riveting machines, gages and testing equipment, metal spraying equipment and many other plant necessities are also included.



SAID THE ELECTRICAL MOUTH TO THE ELECTRICAL EAR . . .

"Joe took father's shoe bench out.
She was waiting at my lawn."

If you were passing through the Bell Telephone Laboratories today you might hear an electrical mouth speaking this odd talk, or whistling a series of musical notes, to a telephone transmitter.

This mouth can be made to repeat these sounds without variation. Every new telephone transmitter is tested by this mouth before it receives a laboratory or manufacturing O.K. for your use. This is only one of the many tests to which telephone equipment is subjected in the Bell Telephone Laboratories. And there is a reason for the selection of those particular words.

It happens that the sentence, "Joe took father's shoe bench out," and its more lyrical companion, "She was waiting at my lawn," contain all the fundamental sounds of the English language that contribute to the intensity of sound in speech.

Busily at work in the interest of every one who uses the telephone is one of the largest laboratories in the world. The development of the telephone in this country is proof of the value of this research. In times like these, the work of the Bell Telephone Laboratories is especially important.

BELL TELEPHONE SYSTEM

The Bell System is doing its part in the country's program of National Defense

AMERICAN STANDARDS ASSOCIATION

R. E. Zimmerman, Vice-President of the United States Steel Corporation, was elected president of the American Standards Association at the Annual Luncheon Meeting held at the Hotel Astor, New York. Mr. Zimmerman has served as Vice-President of the Association since 1938, and has been a member of the Board of Directors since 1937, when he was nominated for membership by the American Iron and Steel Institute. Mr. Zimmerman is well known both in industrial and educational circles. He is a member of the Metallurgical Advisory Board, the Carnegie Institute of Technology, Trustee of Hood College, and Member of the Corporation of the Massachusetts Institute of Technology.

Mr. Zimmerman will succeed Edmund A. Prentis, of the firm of Spencer, White and Prentis, who has served as President of the American Standards Association for the past two years. Mr. Zimmerman is a member of the Welding Research Committee of the AMERICAN WELDING SOCIETY.

R. P. Anderson of the American Petroleum Institute was re-elected chairman of the Standards Council which is in charge of all A. S. A. technical work. Dr. Anderson has taken an outstanding part in developing standardization in the petroleum industry. He has been a member of the A. S. A. Standards Council since 1934, as a representative of the American Petroleum Institute. This is his second term as chairman of the Standards Council.

ENGINEERING DEFENSE TRAINING

Dean S. C. Hollister, of the College of Engineering, Cornell University, has been appointed regional adviser for the State of New York outside New York City on the new national program for Engineering Defense Training. Congress appropriated $9,000,000 for special engineering courses at the college level, to be given at government expense. The objective is to train 30,000 students with technical backgrounds to meet future needs of both industry and government in carrying out the defense program.

According to the statement from the Office of Education in Washington, "Courses of study will be given by the colleges both for those able to devote their entire time to preparation for future defense jobs and for workers now employed who desire to fit themselves for more responsible assignments. All instruction will be of college grade equivalent to that given regular candidates for a degree but the special courses, which will require from 2 to 8 months of study, will concentrate upon training of immediate practical application to specific defense jobs. Classes will be held both at the engineering schools and in or near industrial plants for the benefit of part-time and evening students. The regular college teaching staffs will be supplemented by additional teachers including specially qualified men from the industries to be served."

Dean Hollister for several weeks has been in constant touch with state schools involved: Clarkson College of Technology, Rensselaer Polytechnic Institute, Union College, Syracuse University, the University of Rochester, the New York State College of Ceramics at Alfred, besides Cornell.

In this program, Dean Hollister acts as a liaison officer maintaining continual contact with defense industries, Army and Navy district offices, employment services and other sources of information on personnel needs, as well as with local engineering schools equipped to meet demands for training courses as they arise. He is keeping the Washington headquarters continually informed so that deficiencies in any one region may be met, if necessary, by training students in other places where facilities are available.

A survey of the needs of industries in Southern Tier counties of New York State, where courses might be offered by Cornell, has been made by the College of Engineering here. Courses will be set up as rapidly as possible.

FIBERGLAS

A unique exhibition by the Owens-Corning Fiberglas Corporation was held in the Waldorf-Astoria in New York on November 26th on Fiberglas. Of special interest to the welding industry were the insulation developed for welded piping, electrical machinery insulation which enables reduction in size of motors in generators for same capacity and Fiberglas textiles.

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The custom-made wire for exacting welders

Bare Welding Electrodes • Covered Welding Electrodes
Gas Welding Wire • *Roebling Welding Cables: Made in a complete line of rubber and braided types for arc welding purposes.*
John A. Roebling's Sons Company, Trenton, N. J.
Branches in Principal Cities

ONLY A FINE PRODUCT MAY BEAR THE NAME ROEBLING

PROCUREMENT INSPECTORS

More procurement inspectors are needed at the Air Corps, Wright Field, Dayton, Ohio, for the following branches of inspection: Aircraft, engines, instruments, parachutes, aircraft propellers and tools and gages.

The Civil Service Commission has been seeking experienced men for these jobs but it announces that a new type of position has just been added to those to be filled—that of Junior Procurement Inspector, $1620 a year. The upper grades pay from $2000 to $2600 a year. (All salaries are subject to a 3½ per cent deduction for retirement annuity.)

This work is an important part of the National defense program. Apply for details to the Secretary, Board of U. S. Civil Service Examiners, Wright Field, Dayton, Ohio; to any first- or second-class post-office; to the U. S. Civil Service Commission, Washington, D. C., or to any of the Commission's district offices.

HEATING AND VENTILATING RESEARCH

Careful systematic planning for all engineering projects demands both comprehensive information and available laboratory facilities for investigating special problems. As a service to the engineering profession the Committee on Research of the American Society of Heating and Ventilating Engineers offers a booklet with an outline of engineering data which are available through its various channels of publication. In addition, organized and experienced research laboratory facilities are outlined which are available for investigating special heating, ventilating and air conditioning engineering problems. A bibliography of research reports emanating from the A. S. H. V. E. Research Laboratory and cooperative institutions covering work done on a variety of subjects accomplished over a period of twenty-one years is also listed in this booklet for detailed reference.

FEDERAL EMERGENCY TRAINING PROGRAMS

Craftsmen from three plants of the Westinghouse Electric & Manufacturing Company have been granted leaves of absence to train unemployed men under the Federal Emergency Training Program. The Company has furloughed these expert welders and machine-tool operators so that they may assist in the training programs in Jersey City, N. J., Philadelphia and Pittsburgh.

Some 400 unemployed men are now receiving machine-operation instruction in Jersey City's Dickenson High School, in preparation for work on an ordnance equipment order at the Jersey City plant of the Westinghouse Electric Elevator Company. Two Westinghouse machinists are assisting the school's instructors.

RUBBER COVER WIRES AND CABLES

The John A. Roebling's Sons Co. of Trenton, N. J., has issued a very attractive book of 36 pages illustrated, covering information on standings, insulations and coverings. The booklet contains useful information to the electrical man.

STEEL CASTINGS HANDBOOK

The Steel Founders' Society of America, 920 Midland Building, Cleveland, Ohio, has just issued a new Steel Castings Handbook of 500 pages. Price $2.00.

"What are the advantages of using steel castings in mechanical structures and assemblies? How can steel castings best serve the engineering industries? What helpful information is available as a guide to steel-casting designers? What should an engineering graduate know about the products of the steel foundry?" This book is an attempt to provide authoritative answers to these and similar questions.

The sources of the material presented are practically co-extensive with the entire Steel Casting Industry, and include the literature on the subjects covered as well as much hitherto unpublished information made available by qualified individuals and corporations both within and outside the Steel Casting Industry.

National

Carbide

DEPENDABLE

EFFICIENT

ECONOMICAL

FOR WELDING and CUTTING

Use National Carbide in the Red Drum

Lincoln Building — NATIONAL CARBIDE CORPORATION — New York, N. Y.

On fine work like this, welders really strut their stuff when they use the recommended PAGE-ALLEGHENY STAINLESS STEEL ELECTRODE.

They get smooth beads and low spatter loss. The weld metal in the welds equals the Stainless they are welding. And the time card looks good—for vertical, overhead or horizontal welds.

Tell your local Page Distributor the type of Stainless Steel you want to weld. You can depend on his recommendation.

Ask for a copy of this Booklet ➡ ➡ ➡

PAGE HI-TENSILE "F"

A mild steel general purpose electrode of the shield-arc type especially recommended for high-speed single pass welding —horizontal, vertical or overhead. Well suited for welding Cro-Man-Sil, Cor-Ten, H. T. 50 and other alloy steels, giving welds with characteristics that better solid rolled mild steel bars.

PAGE HI-TENSILE "G"

A shield-arc electrode for high speed flat fillet and for general horizontal welding. Otherwise, its characteristics parallel those of HI-TENSILE "F".

PAGE STEEL AND WIRE DIVISION • MONESSEN, PENNSYLVANIA

AMERICAN CHAIN & CABLE COMPANY, Inc.

ESSENTIAL PRODUCTS . . . AMERICAN CABLE Wire Rope, TRU-STOP Emergency Brakes, TRU-LAY Control Cables, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Iron Castings, CAMPBELL Cutting Machines, FORD Hoists and Trolleys, HAZARD Wire Rope, Yacht Rigging, Aircraft Control Cables, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*

LOCOMOTIVE OBSOLESCENCE, STREAMLINED CABOOSES

Of 43,000 railroad locomotives nominally in service at the beginning of 1940, 28,700, or 68 per cent, were "of age," Chairman E. G. Young of the Railroad Division told the American Society of Mechanical Engineers at its 61st annual meeting. The percentage of engines 20 years old or more has increased from 58% to 68% during the past five years, emphasizing the "well-known facts of intensive utilization and high-mileage requirements of the newer engines."

There are only 2400 locomotives in service less than 10 years old, and during the five-year period only 1200 have been added to the "youthful" end of the inventory.

Many locomotives used on newly accelerated "hotshot" and "mainliner" merchandise freight services are being pooled with passenger runs and used alternatively, Mr. Young said in giving the annual report on progress in Railway Mechanical Engineering, 1939–40. Principal engineering factors in the new fast freight services are high-wheel locomotives having boiler capacity to sustain power at high speeds; freight cars with modernized trucks and spring arrangements, the AB brake, and general design policy leading to the reduction of tare weight.

Mr. Young declared that:

"For main-line service it seems that the 'drag-freight era' is well on its way out, along with archbar trucks, 63-in. drivers and cars which cannot carry three times their weight or more.

"Several railways gave attention during the year to the matter of improving cabooses. Improved riding qualities, neatness of interior arrangement and convenience of train crews were sought. There is a general movement in the direction of avoiding the structural and other disadvantages of the old-style cupola, and the substitution for this of side observation windows, these observation bays extending about a foot beyond the side of the car, and affording a good opportunity for trainmen to examine the sides of their train, especially in rounding a curve. The cars are well insulated, are generally of welded construction, and are large enough for the convenience of the working crew and a dead-head crew besides. The light weights range around 19 tons."

COURSE IN OXYACETYLENE WELDING PROCESS

A comprehensive course of exercises covering the oxyacetylene welding process for the aviation industry has just been published by Air Reduction, New York. The purpose of this course is to provide a well-planned series of exercises (67) to illustrate all the varied conditions existing in the art of aircraft welding. It can be utilized also to train operators who have had previous experience in other lines of oxyacetylene welding.

This book sells for 50¢ per copy and may be obtained by writing Air Reduction Sales Company, 60 East 42nd Street, New York, N. Y.

A. S. T. M. SPECIFICATIONS FOR PIPE AND PIPING MATERIALS

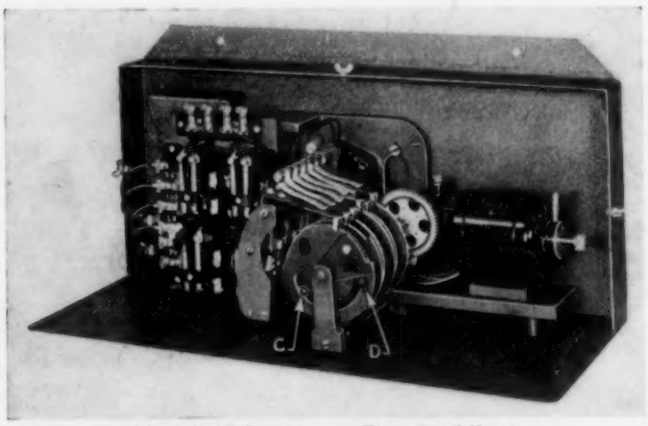
This widely used compilation is a selection of twenty-four of the forty A. S. T. M. specifications covering pipe and piping materials, particularly materials used in high-temperature and high-pressure services. The book provides in convenient form standards which are important to those concerned with power plants and industrial installations of piping materials. It is widely used in other connections by manufacturers and purchasers of materials.

Eleven of the twenty-four specifications cover various types of carbon and alloy steel pipe and boiler tubes, etc., including the specifications for classification and dimensions of wrought iron and wrought steel pipe. Four items cover carbon and alloy steel castings, three pertain to bolting materials including nuts, and there are four items covering forgings and welding fittings. The classification of austenite grain size in steels with two grain size charts is also included.

Copies of this 153-page publication in heavy paperboard cover with special ring binding are available from A. S. T. M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at $1.25. On orders for ten or more copies special prices are in effect

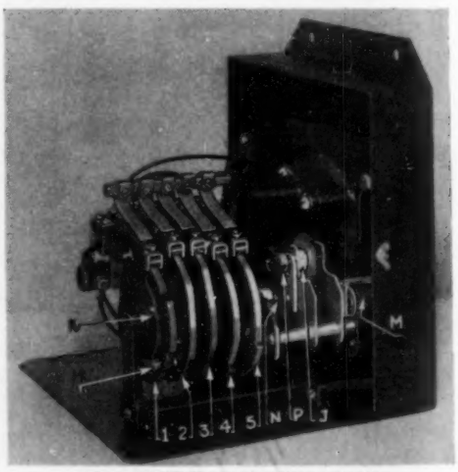
WELDING OPERATIONS FOR THE NATIONAL DEFENSE PROGRAM MUST be FASTER and more CONSISTENT

It makes Little Difference, for Spot Welding ordinary steel plate, ¼ inch thick, or that very flexible, Stainless Steel, "SKIN" stock, measuring .005" in thickness, there is a National Welding Timer, now ready for prompt delivery to meet all of the rigid inspections of Government.



No. 1800P Synchronous Timer for Alloys

Bulletin No. 146 Just Out, Tells All. You should Have it.



No. 1750P Timer for General Use

National Motor Driven Weld-Timers, illustrated here, produce the character of spot weld, that passes the acid test of Aircraft or other important Defense inspection.

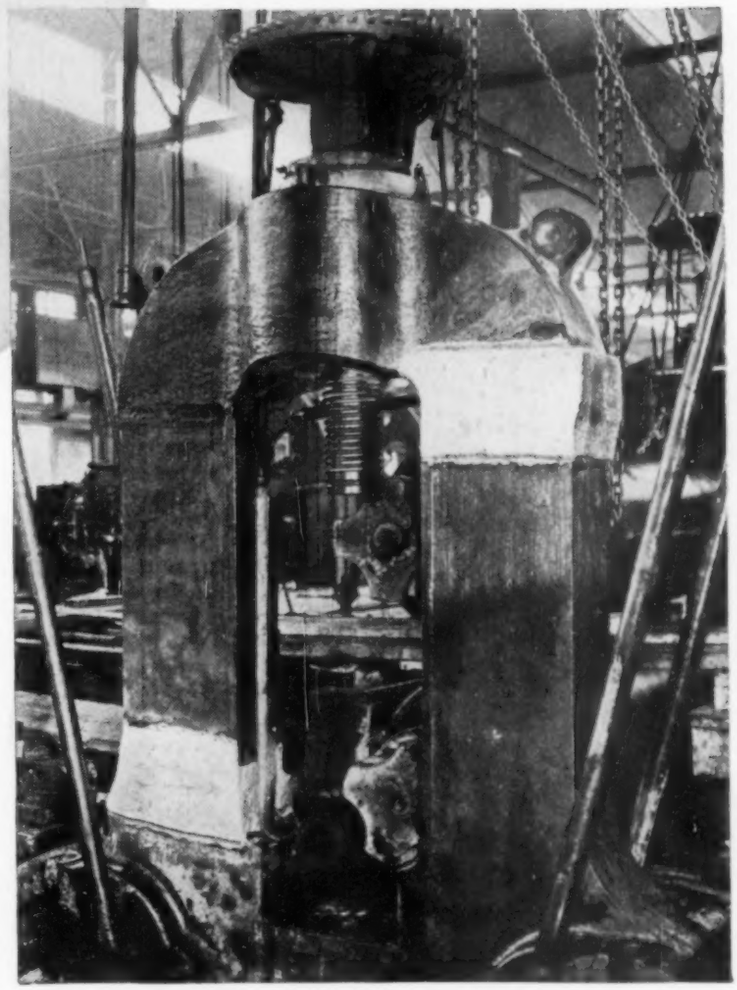
For non-ferrous metals, or alloy steels, the Type No. 1800P Syncro-timer, which opens and closes the weld current on zero, at any desired point from ½ cycle weld time up, is the "old reliable" with Murray Corporation.

NATIONAL TIME & SIGNAL CORPORATION

600 E. MILWAUKEE AVENUE **DETROIT, MICHIGAN**

How strong is a 400-lb. Tobin Bronze weld? How quickly can it be made?

The story of the repair welding of this 15-ton roll housing reveals the answers to these important questions...



LAST March 8, this huge housing on a 33" rolling mill cracked resoundingly and thundered to the floor. Production orders were heavy on this particular mill and a replacement could not have been made for eight or nine weeks. To save time, two temporary repair-welds with Tobin Bronze were tried. Welders, working steadily in two shifts, used 400 lbs. of Tobin Bronze 3/8" welding rods for each weld; consumed only nine days to complete the work. On March 17 the housing was back in place ready to go...So much for how quickly welds of Tobin Bronze can be made.

Production was resumed, the plant superintendent hoping that the repaired housing would stand up under terrific operating pressures of the rolls until a new casting could be obtained. Six months later that mill was still rolling its quota of metal. *What's more,* during this period, a roll neck broke in the housing. The abnormal stress that brought about the fracture in the heavy roll was absorbed by the welded housing with no sign of failure. Such service is proof positive of the high strength of properly made Tobin Bronze welds in cast iron.

Tobin Bronze welding rods are stocked by all leading supply houses. Make sure that when you buy Tobin Bronze it bears the trade-mark "Tobin Bronze—Reg. U. S. Pat. Off."—only then you will be getting the genuine. 40115

ANACONDA **Anaconda Welding Rods**

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

In Canada: Anaconda American Brass Ltd., New Toronto, Ont. • Subsidiary of Anaconda Copper Mining Company

INDUSTRIAL RADIOGRAPHY

Industrial Radiography, by Ancel St. John and H. R. Isenburger, published by John Wiley and Sons, Inc., New York. Price $3.50.

It has been the purpose in preparing this book to present the practical aspects of industrial radiography in a form and language which can be understood by students, laymen and engineers, who desire to obtain some useful knowledge of the basic theories which are involved. No attempt has been made to produce a scientific treatise or a comprehensive work of all the theories.

The authors hope that it will help workers in this field to perform their investigations or inspection more easily, stimulate teaching and study of industrial radiography in technical schools and serve to direct the attention of engineers and others to the potential value of this new technique in activities where hitherto its use has not been fully realized.

RESISTANCE WELDING

By J. W. Meadowcroft*

The volume of research work in the resistance welding field during the past few years will be more than doubled in 1941. Results from such welding research are proving of immense value in meeting the speed requirements of our National defense program, and will be of primary importance in the subsequent adjustments during the economic crises that will follow.

The theories worked out in the research laboratories are being applied in a practical way in every field in industry to manufacture products of much higher quality and at lower costs.

Through a continuation of resistance welding research we can anticipate a steady improvement in the quality of products fabricated by the resistance method of welding. Manufacturers of resistance welding equipment by applying the findings of the research laboratories, will undoubtedly build machines of a higher standard of efficiency than ever produced before, which will not only be of great assistance to industry in the United States, but will be superior to any other resistance welding equipment in the world.

There will be closer cooperation among the engineers who design resistance welded structures, the research laboratories and the welding engineers.

Without any question of doubt, I predict that more progress will be made in the use of resistance welding in the next three years than has been made in the last quarter of a century.

* Assistant Works Manager, Edward G. Budd Manufacturing Co.

MUREX DISTRIBUTORS

Industrial Equipment Co., Birmingham, Ala.; Morgans, Inc., Savannah, Ga.; D. J. Murray Mfg. Co., Wausau, Wis.; and George Rumble, Toronto, Canada, have recently been appointed distributors of Murex Heavy Coated Electrodes by Metal & Thermit Corporation, New York, N. Y.

All of these supply houses will stock the complete Murex line, including mild steel electrodes for downhand, for fillet welding and for vertical and overhead work; low alloy electrodes for welding Cor-Ten, Mayari and other high strength steels; and manganese steel and hard surfacing electrodes.

HOBART DISTRIBUTOR

A. C. Harvey Co., Allston, Mass., who have been identified for years with the sale of steel products and welding equipment in New England, have been appointed jobbers of the line of Hobart "Multi-Range" Arc Welders, to collaborate with Leo Gordon of the New England distributing office.

CASTOLIN LOW TEMPERATURE BRAZING AND WELDING EUTECTIC ALLOYS

The new Castolin Low Temperature Welding and Brazing Eutectic Alloys, which were first imported into this country, have received such a reception in all fields of industry as well as for manufacturing and maintenance, that it is now necessary to produce these alloys in this country. The Eutectic Welding Alloys, Inc., 40 Worth St., New York has acquired the exclusive license for manufacturing and distributing these rods in the United States.

These new rods have the property of binding on the heated surface of most any metal. But the base metal does not become molten; there is fusion of the molten rod with the heated surface. Micrographic pictures prove a complete penetration and diffusion by capillarity inside the welded metal. Chemically this bond is absolutely perfect and reliable. Tests carried out for many years have shown that there will be no electrolytic disintegration. This method has proved to be a most sound and reliable medium for joining and overlaying similar and dissimilar metals.

RADIAGRAPH

A new 8-page booklet has just been published by Air Reduction, New York, featuring the No. 4 Radiagraph—a Portable Motor-Driven Gas Cutting Machine. The first four pages are devoted to a discussion of the general operation and construction features. This section points out how the machine is ideal for making straight line cuts, for cutting arcs or complete circles and for cutting irregular shapes involving long sweeping curves, either simple or compound. Such operations can be performed with accuracy when making either square or bevel edges.

The second half of the book is devoted to a description of flame hardening and plate edge preparation operations which can be accomplished by using the Standard No. 4 Radiagraph with special, easy-to-attach equipment.

Copies of this bulletin may be had by writing Air Reduction Sales Co., 60 East 42nd Street, New York, N. Y.

FABRICATING METHODS FOR STAINLESS CLAD STEEL

The most recent advances in the methods of fabricating and welding stainless clad steel are to be found in a new booklet just issued by Ingersoll Steel & Disc Division, Borg-Warner Corporation, 310 South Michigan Avenue, Chicago. This latest 16-page booklet bears the same title as earlier editions—"Manual of Welding and Fabricating Procedures for IngAclad Stainless Clad Steel."

It differs from the previous editions in that it is entirely new in form and in presentation with a complete revision text and diagrams illustrating welding and fabricating procedures. Improvements in technique to assure the maximum strength, corrosion resistance and ductility in welded fabrication have been emphasized.

ARC WELDING SCHOLARSHIPS GIVEN TO TWO

Victor D. Filimon, and Emory D. Hecox, are recipients this year of the Arc Welding Scholarships in welding engineering.

Established in 1939 through the generosity of an anonymous donor, the two scholarships of $250 each are awarded each year to the two ranking students of the junior and senior classes of the department of welding engineering.

Selections are made by a faculty committee during the preceding spring quarter, on the basis of scholastic record, character and personality, and interest and ability. The committee is composed of Charles E. MacQuigg, dean of the College of Engineering, chairman; Prof. E. E. Dreese, chairman of the department of electrical engineering; Prof. John Younger, chairman of the department of industrial engineering; Dr. J. R. Stitt, assistant professor of welding engineering; and a fifth member chosen by the group.

Discussed at Meeting

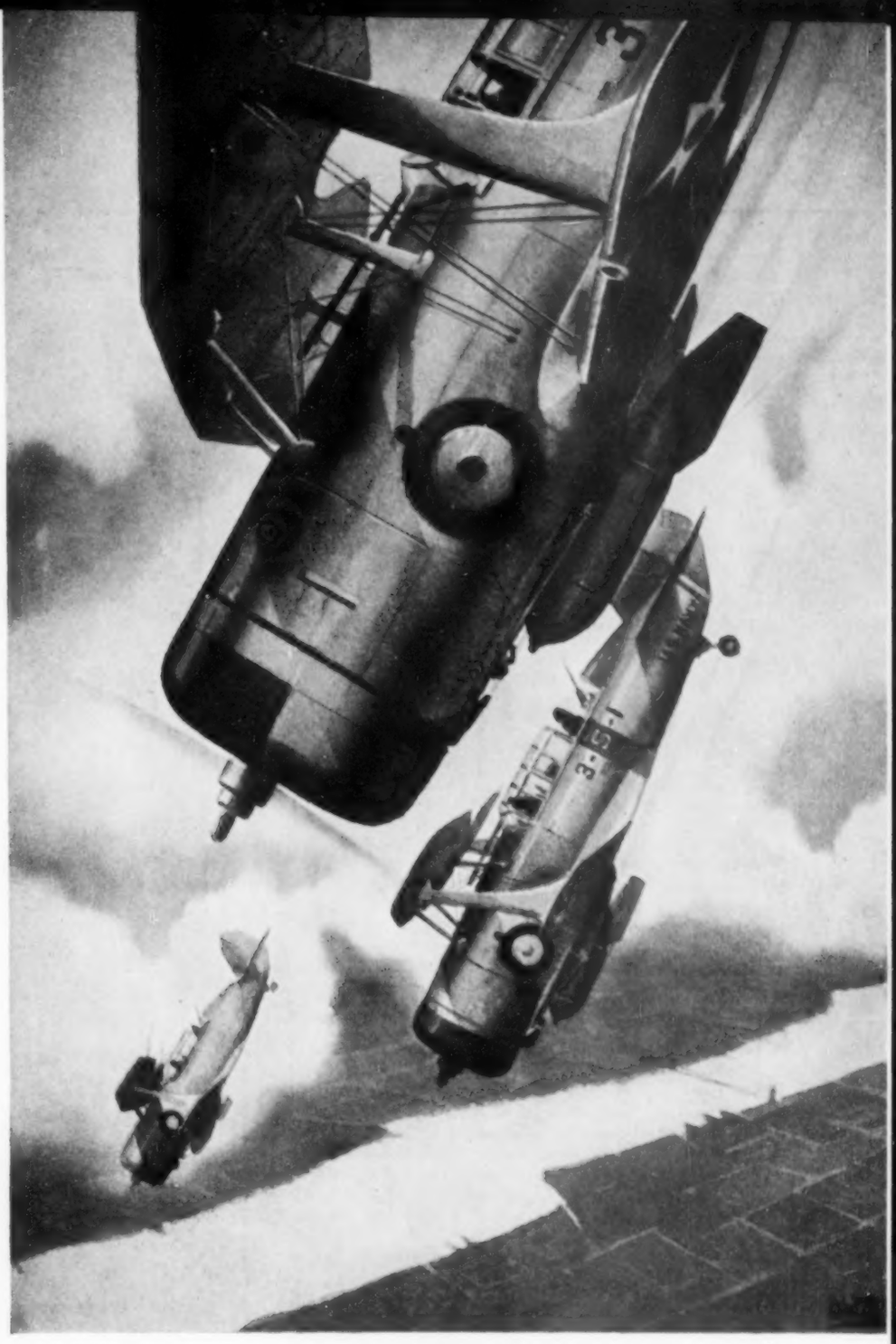
A discussion of the arc welding scholarships will be part of the program of the first meeting of the student section of the AMERICAN WELDING SOCIETY, at 7 P.M. Wednesday at the Ohio Union. "20 Years of Welding Development" will be the other topic of the evening.

CORRECTION YEAR BOOK

An error was made in the title of Mr. Robert D. Williams in the Year Book. The correct listing should be as follows:

"Associate in Mechanical Engineering, Dept. of Mech. Eng., University of Illinois, Urbana, Ill."

IVE BOMBERS IN ACTION



ON WELDED WINGS

Modern, efficient and dependable as the planes they help to weld are the Torches and Regulators made by

VICTOR **EQUIPMENT COMPANY**

844 Folsom Street · San Francisco

Distributing Points From Coast to Coast

We should like you to have illustrated literature—please write

DEFENSE BOTTLENECK RELIEVED BY WELDING

Welded construction can get industry out of the machine tool bottleneck of our Defense Program by a reduction of more than 25% in machining time for finished products according to statistics released today by The James F. Lincoln Arc Welding Foundation.

In figures compiled under direction of the board of trustees, from 109 welding case studies of engineers, designers and others in important divisions of industry, the Foundation reveals that welded products take an average of 25% less time to machine than the same products in cast construction.

Fifteen examples, on which savings in machining run up to 46%, are cited in the statistics.

With a present annual capacity of only $450,000,000, the machine tool industry would need nearly 2 years to turn out these requirements.

Authors of studies from which the statistics were obtained, report that welded construction requires less machining because it uses standard rolled steel shapes and plates. These can be ordered right from the mill or supplier in correct sizes and thicknesses to meet design requirements. The excess metal, which must be used to facilitate the casting operation in cast construction, and which must be machined off in the finishing operations, is done away with by welding.

Comparing welding with riveting, welding requires less machining because there is no need of drilling or punching holes which are required for the riveted connections. Nor is there any need for cutting and machining connecting members since welding joins structural parts directly together.

The Foundation now has under way a program of industrial study of arc welding which it is stimulating by establishment of 458 awards totaling $200,000.

Savings in Machining Time and Cost for Welded Products

(Data reported in industrial case studies by engineers, designers and others.)

Product, Structure or Part	Machining Time and Cost Former Construction Time (Hr.)	Cost	Welded Construction Time (Hr.)	Cost	Machining Saved by Use of Welded Construction Time (Hr.)	Cost	%
Deep well pump	40	$32.00	24	$19.20	16	$12.80	40
Milling fixture	23	18.62	16	12.74	7	5.88	30
Movable and stationary die	25	20.46	18	14.70	7	5.76	28
Drill jig for tractor front axle	22	17.93	16	12.76	6	5.17	27
Bulldozer die for tractor steer rod	21	16.66	19	14.90	2	1.76	9½
Boring fixture	54	43.12	45	36.25	9	6.87	16½
Drilling fixture for field truck axle	15	11.76	12	9.80	3	1.96	20
Drill jig for center plate of tractor	27	21.56	22	17.64	5	3.92	18½
Locomotive guide yoke	26	20.62	20	16.00	6	4.62	23
Metal cutting machine	19	15.00	12	10.00	7	5.00	37
Dust collecting bench	65	51.63	35	28.38	30	23.25	46
Copper sheet coiling machine	160	128.00	128	102.00	32	26.00	20
Oil well spudder housing	131	105.00	100	80.00	31	25.00	23½
Die cutting press	244	195.00	206	165.00	38	30.00	15½
Vacuum pump	309	247.20	178	142.40	131	104.80	42

NOTE: Figures based on the present rate (80¢ per hour) for skilled labor in the machine tool industry.

LOADING TOWER

Shown in the accompanying illustration is a loading tower at Gilman Coal and Coke Co., at Dravosburg, Pa., of welded

Just ONE set-up for every weld

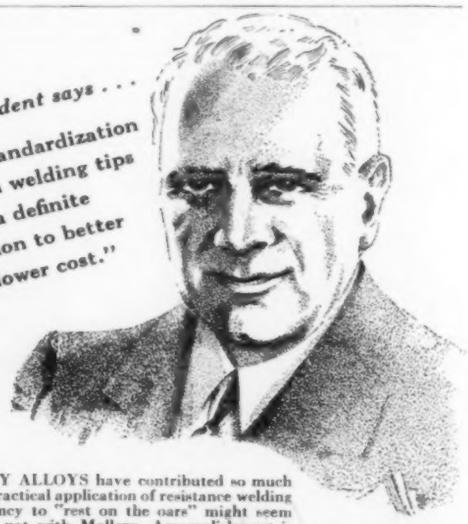
Save valuable time in welding, handling; do better "downhand" welding—all with more safety, by using a C-F Positioner. Cut down crane service on large unwieldy work by "setting-up" just once for all welds. C-F Positioners are made in hand and power operated models with a variety of control features suitable for all kinds of work. Send coupon today for complete information about these remarkable welding machines which give every advantage to today's production demands.

CULLEN-FRIESTEDT CO.
Gentlemen: Please send circular No. W-P20.
Name
Title
Address

Circular No. W-P20 describes C-F Positioners from 1,200 to 14,000 lb. capacity.

CULLEN-FRIESTEDT CO.
1309 S. KOSCIUSKO AVE. CHICAGO ILLINOIS

The President says . . .
"Mallory's standardization program on welding tips has made a definite contribution to better welds at lower cost."



MALLORY ALLOYS have contributed so much to the practical application of resistance welding that a tendency to "rest on the oars" might seem natural. But not with Mallory. Accomplishment is simply a challenge to further progress.

Mallory's research and development in the field of standardization of welding electrodes is typical. Years of work and collaboration with leading machine manufacturers has resulted—at a lower cost—in standardized, replaceable welding electrodes for every purpose and every machine. They completely eliminate lost time in waiting for special orders to be completed.

If you are not using Mallory Standardized Welding Electrodes, be sure to get all the facts now. You can be sure of obtaining the right electrode for your particular job . . . and for the machines you use.

P. R. MALLORY & CO., Inc., Indianapolis, Indiana · Cable Address — PELMALLO

P. R. MALLORY & CO. Inc.
MALLORY
RESISTANCE WELDING ELECTRODES

FIFTEEN YEARS PROGRESS BY RESISTANCE WELDING

First consideration on many bids today is speed—speed in delivery. Therefore, if welding is a factor, or a possibility, call in a Resistance Welding Engineer first, before you bid. While the job is in blueprint form, he can help you figure the fastest and most economical method of fabrication. He will be able to apply experience from many years of welding progress to your problem—speeding production, lowering fabrication costs, improving design. Any of the member companies listed here will be glad to consult with you and place a competent welding engineer at your disposal.

RESISTANCE WELDER MANUFACTURER'S ASSOCIATION

505 Arch Street Philadelphia, Pa.

RESISTANCE WELDER MANUFACTURERS ASSOCIATION • RWMA

MEMBER COMPANIES

National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Company, Detroit, Mich.
Swift Electric Welder Company, Detroit, Mich.
Taylor-Hall Welding Corporation, Worcester, Mass.
Taylor-Winfield Corporation, Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Welding Machines Mfg. Co., Detroit, Mich.
Acme Electric Welder Company, Huntington Park, Calif.
Eisler Engineering Company, Newark, N. J.
Expert Welding Machine Co., Detroit, Mich.
Federal Machine and Welder Company, Warren, Ohio
Multi-Hydromatic Welding and Manufacturing Co., Detroit, Mich.

ASSOCIATE MEMBER COMPANIES

Electroloy, Inc., New York City
Welding Sales and Engineering Co., Detroit, Mich.
P. R. Mallory and Co., Indianapolis, Ind.
S-M-S Corporation, Detroit, Mich.

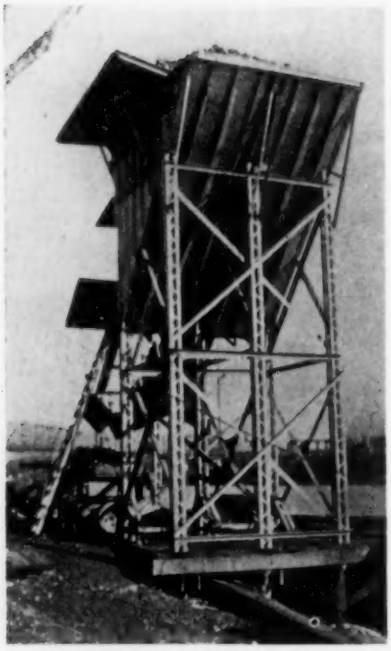


Photo courtesy Lincoln Electric Company

Arc-Welded Loading Tower Erected by Maintenance Department, Gilman Coal & Coke Co., Dravosburg, Pa.

steel construction built by the company maintenance department. Advantages claimed for welded construction include simplified fabrication and erection due to minimum amount of layout and detailing work.

It was laid out and built from standard mill shapes right at the erection site. It is estimated that savings over riveting due to reduced number of operations and minimum amount of material were 40%. Smooth interior of hopper due to welded construction assures free-running coal.

Columns are fabricated from $3^1/_2$ x $3^1/_2$ x $^5/_{16}$-inch angles joined by lattice work of 10 x $1^1/_4$ x $^5/_{16}$-inch bar stock. The columns rest on a base plate 24 x 24 x 1 inches. Columns are braced by diagonals of $4^1/_2$ x $4^1/_2$ x $^5/_8$-inch angles and by horizontal frame members of the same size. Bottom of bin is $^1/_4$-inch butt-welded plate. Sides and top are $^3/_{16}$ inch. Bin is 13 feet wide, 26 feet long, 18 feet deep, with a capacity of 75 tons. Foundation of tipple is concrete.

Time required for construction was 3 weeks in shop, employing a welder and a helper, and 5 days for erection, employing 2 welders and 2 helpers.

S.S. MORMACTIDE

Below is shown a picture of the S.S. *Mormactide*, stern view, taken just prior to the launching on October 12th, at the Pascagoula, Mississippi, yard of The Ingalls Shipbuilding Corporation.

The S.S. *Mormactide* was constructed for the Moore-McCormack Lines, Inc., New York, and will operate between Boston, New York and the east coast of South America. The new ship is of C-3 design, with 17,600 tons displacement, is 492 feet long, with a capacity of 720,000 cubic bale feet of cargo, including 10,000 cubic feet of refrigerated cargo. There are accommodations for twelve passengers and the vessel travels at a speed of 18 knots.

Mr. Emmet J. McCormack, Vice-President of Moore-McCormack Lines, Inc., headed a large delegation of guests

who came from New York to Pascagoula for the launching. He made the statement that the Ingalls yard was not merely building a ship, but also a most effective ambassador, who would carry the message of the United States to very important neighbors. He emphasized the fact that the builders were performing a patriotic duty when they constructed a good ship.

The S.S. *Mormactide* is 100% all welded throughout, as the Ingalls organization only constructs vessels of this type.

FACTORY ADDITIONS

Factory additions to take care of increased production requirements in connection with the National Defense Program are quickly erected by simple, arc-welded steel construction, in one-third the time and with substantial savings in cost. By this method, additions may be completed in relatively small sections so

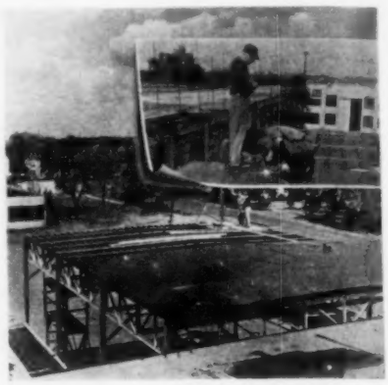


Photo courtesy Hobart Brothers Co.

that production activities may expand just as rapidly as possible. In the foreground here one section is nearing completion, while a completed section appears in the background. Framing, roof and side walls, including window sash and frames are of arc-welded steel.

BUILD IRON LUNG TO MEET CRISIS

The successful construction of an emergency mechanical respirator by 30 metal shop workers to save the life of a co-worker's 10-year-old son, stricken with infantile paralysis, was noted recently in Grand Rapids, Michigan.

The youth, Cabell Pratt, son of Percy P. Pratt, western division engineer of Post Products Company, sheet metal fabricators, was stricken on Sunday.

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them

The Trade-Name is "ANTI-BORAX"

Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

Send for Free Samples

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

SHAWINIGAN CARBIDE

For
OXY-ACETYLENE WELDING AND CUTTING OF METALS

SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BUILDING
NEW YORK, N.Y.

Announcing

NEW

ALL-PURPOSE A-C FLEXARC

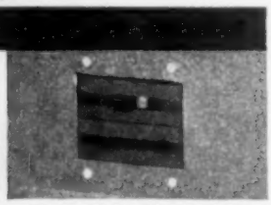
The A-C Welder For General Utility Work 20-250 Amperes Range

ONLY

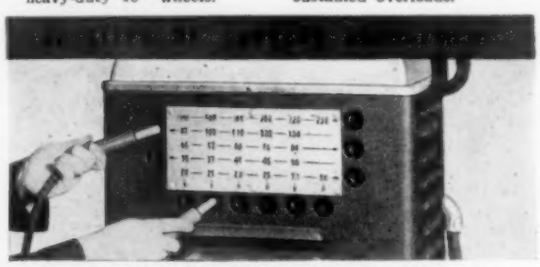
$198.00

COMPLETE WITH ALL ACCESSORIES

A slight push on the foot bar, an easy pull on the hand rail, and the new welder is ready to roll away on its heavy-duty 10" wheels.



The built-in Westinghouse "De-ion" breaker permits shutting down at the machine and protects against sustained overloads.



Current is adjustable in 27 steps from 20 to 250 amperes. Steps are clearly indicated. Plug in and you're ready to weld.

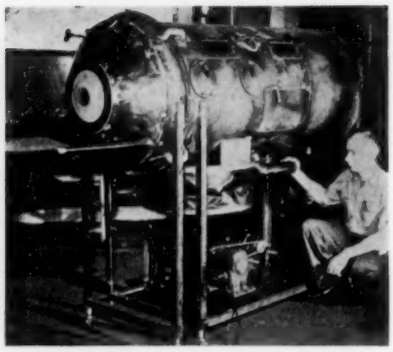
Price includes complete equipment; welding helmet with lens, welding leads, scratchbrush, electrode holder, generous length of primary cable and 17 lbs. of assorted electrodes.

See the New All-Purpose FlexArc on display at your nearest Westinghouse Welding Dealer. With a complete line of Westinghouse FlexArc Welders and Westinghouse FlexArc electrodes for both a-c and d-c he can supply the equipment best suited to your requirements. For information write Dept. 7-N, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

J-70275

Westinghouse

FLEXARC A-C WELDERS



Iron Lung "Tailor-Made" by Arc Welding in Post Products Co., Metal Shop, Grand Rapids, Michigan, Met Emergency When No Standard-Type Respirator Was Available for a 10-Year-Old Victim of Infantile Paralysis

Following a frantic but fruitless statewide search for a respirator, the father reported his dilemma to the chief engineer and, at 9:30 Tuesday morning, the actual job of constructing the "lung" began. The 30 workmen toiled continuously for 28 hours, working all night Tuesday. Structural details were taken from one of two standard Drinker-Collins iron lungs in use at local hospitals, and an engineer produced the plans for the emergency unit.

Setting to work, the men cut the parts of the breathing machine from 14-gage sheet metal and arc welded the pieces together by the modern shielded arc process. Then they installed wires, valves, gages and electric motors. Framework is of angle iron arc welded. Portability is provided by 6 casters, on which the unit is mounted.

The "Tailor-made" breathing machine, completed at 1:30 P.M. Wednesday, three full days before the disease reached its crucial stage, was accurate to the last detail.

Construction of the lung, which ordinarily would require many weeks and cost $1350, was made possible, in such short time and at a low cost, by the electric-arc process of joining metals. By this process, the fabricator simply cuts metal to the sizes needed and fuses the pieces directly together. No time or labor is required in locating rivet holes, punching them, lining them up, inserting gaskets and heading up the rivets.

BRAZED PARTS IN PLACE OF CASTINGS

Silver brazing alloys are opening up fast, economical ways of making parts for many purposes which, not very long ago, would have called for castings. The heater valve body illustrated, for example, was assembled entirely by brazing. It is made of two pieces of tubing with 20 B. & S. gage walls, a brass bracing piece between the curved and straight tubes, a stamping of steel at the base and a valve seat of stainless steel inserted inside the large diameter of the straight tube. The entire part was set up, fluxed, the brazing alloy preplaced and then the assembly was put in a furnace and brazed in one operation. The brazing alloy used was a silver alloy which has a medium silver content and flows freely at 1175° F. Rings of wire were preplaced around the joints to be made before heating. In addition to eliminating casting and the machining of parts, this alloy also joins several dissimilar metals. In this instance copper, brass, steel and stainless steel were permanently bonded together. Joints in this case must be leak-tight. It is reported that finished parts, which are being made in quantity, are coming through very satisfactorily with a very low percentage of rejects.

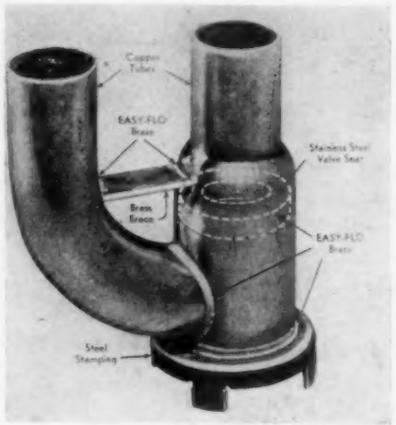


Photo courtesy Handy & Harman, New York, N. Y.

DEEDS CARILLON

The "Deeds Carillon" is a shaft of steel, granite and limestone 170 feet high with 32 bells, erected as a gift to the city of Dayton, Ohio, from Mrs. Edward A. Deeds, wife of the Chairman of the Board of The National Cash Register Company. Architects were Reinhard and Hofmeister of New York City. Bells furnished by Meneely Bell Company of Troy, New York. Steel fabrication and erection was handled by The Burger Iron Company of Akron, Ohio, and Dayton, Ohio.

Photos courtesy The Hobart Brothers Co., Troy, Ohio.

The framework for the four steel towers was fabricated in the shop, each tower in five sections. The sections were all welded, the only holes being for erection purposes. The erection splices were arc welded in the field, after which all bolts were removed and the holes plug welded. The bell hanger was also of arc welded construction and is suspended from the joining arches at the top of the four towers.

Total weight of the tower is 102 tons and over-all height of the steel work is 157 feet 6 inches. The largest bell,

SAVE MONEY . . . BY WELDING

Jaw Plates, Gyratory and Roll Crushers, Shovel Teeth, Hammers, Tractor Tread Grousers

with

MANGANAL

Reg. U. S. Pat. Office. U. S. Patents 1,876,738—1,947,167—2,021,945

11 to 13% Manganese Nickel Steel

WELDING ELECTRODES, WEDGE and APPLICATOR BARS, HOT ROLLED PLATES

STULZ-SICKELS CO. *Sole Producers* 134-142 Lafayette St., Newark, N. J.

Sold Thru Distributors Only

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Black and White *Effective May 1938*

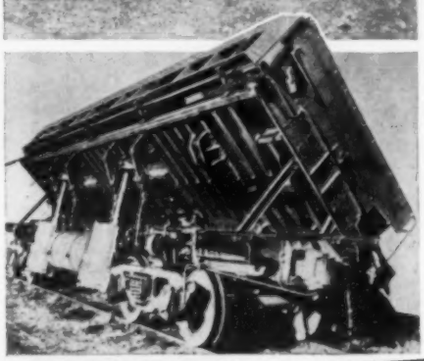
Space	One Insertion	Three Insertions	Six Insertions	Twelve Insertions
*Full Page	$100	$90	$80	$70
Half Page	60	50	45	40
Quarter Page	35	30	27	25
Eighth Page	25	20	17	15
*Inside Preferred	115	105	95	85

*10% Extra for bleed full pages. Color $40 extra per color added.

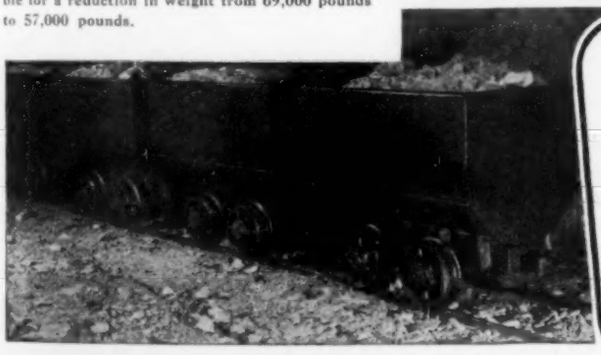
MINING PAYS *Bigger Dividends*

— thanks to *welded* equipment, built lighter from stronger, longer-wearing **ROLLED STEELS**

Giant coal stripping shovel, built by the Marion Steam Shovel Company, increases dipper capacity from 18 to 23 cu. yds., with no reduction in dipper strength, by replacing the heavy cast dipper with one built of U·S·S MAN-TEN Steel.



A 20% saving in weight—greater strength—obtained by using U·S·S MAN-TEN and welded construction to fabricate these rotary ore dump cars. And MAN-TEN's ability to resist abrasion—to stand up under gruelling treatment—will make them wear longer.



6 Cars Weigh Less Than 5—Arc-welded, low alloy steel used throughout in the construction of this 30 cu. yd. railroad dump car was responsible for a reduction in weight from 69,000 pounds to 57,000 pounds.

COAL and ore move faster and at lower cost in welded, rolled steel equipment. And it's easy to see why!

Because it puts steels with special properties to work in strategic places, rolled steel construction, replacing other types of fabrication, has increased capacity without increasing weight, given greater strength with no addition of profit-eating poundage, made parts subject to severe abrasion wear longer. One company, for example, used rolled steel welded construction in a dipper bucket's swivel guide — and saved 5000 pounds of deadweight. Another saved 20% on mine car weight. Still another increased the handling capacity of its refuse buckets by approximately 40%.

Results like these a few years ago might have seemed impossible. Today they are commonplace throughout industry. Welded rolled steel construction has come into its own! We'll be glad to show you how it can improve your product or your machinery.

For lighter, stronger, longer-wearing mining equipment fabricate it by welding with these better steels:

U·S·S Cor-Ten—to resist corrosion, to reduce weight or increase strength.

U·S·S Man-Ten—to increase strength without adding weight.

U·S·S Abrasion Resisting Steel—for use where abrasive conditions are exceptionally severe.

U·S·S Heat Resisting Steel—to combat high temperatures.

U·S·S Stainless Steel—to resist corrosion of all kinds.

U·S·S Carilloy Alloy Steels—to carry tremendous bearing pressures.

CARNEGIE-ILLINOIS STEEL CORPORATION, *Pittsburgh and Chicago*
COLUMBIA STEEL COMPANY, *San Francisco*
TENNESSEE COAL, IRON & RAILROAD COMPANY, *Birmingham*
United States Steel Export Company, New York

UNITED STATES STEEL

CASTING	
Weight	17.5 lbs.
Material	$ 0.875
Labor	0.00
Total	$ 0.875

STEEL	
Weight	12.5 lbs.
Material	$ 0.33
Labor	0.21
Total	$ 0.54
Saving over casting	$0.335

STEEL	
Weight	11.0 lbs.
Material	$ 0.29
Labor	0.13
Total	$ 0.42
Saving over casting	$0.455

six feet in diameter, weighs 7000 pounds while the smallest, twenty inches in diameter, weighs 150 pounds.

WELDING IN EVOLUTION OF WHEEL

The accompanying illustration, supplied by The Lincoln Electric Co., Cleveland, Ohio, shows an interesting example of the ultimate result accomplished by application of welding to a machine part.

The cast wheel shown at left weighed 17½ pounds and cost 87½¢. The first redesign for welding (see center of illustration) weighed 12½ pounds and cost 54¢. The ultimate design, shown at right of illustration, weighs 11 pounds and costs 42¢.

Each redesign accomplished savings in both weight and cost. The first welded steel wheel reported 38% saving over the castings, while the final design accounted for a saving of 48% over the casting. Redesign of the first welded wheel showed a saving of 22%.

Details of the construction of the two welded designs can be seen in the illustration. In the first, it was a direct replacement of the casting containing 6 spokes, a rim and hub. The present wheel, a much better utilization of welded construction, has two pieces of steel for spokes, a piece for the hub and the rim made out of rolled channel.

CAPACITY OF HYDRAULIC PRESS IS DOUBLED BY NEW PLANT

With its modern new plant at Mount Gilead, Ohio, now in full operation, The Hydraulic Press Manufacturing Company has increased its manufacturing capacity by 100 per cent.

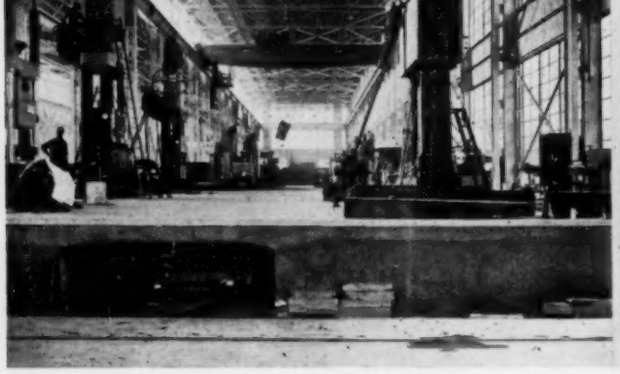
Straight-line production is applied in the building of presses for aircraft, automotive, general metal-working and process industries in the new manufacturing area, where modern materials and building equipment have been combined in a strictly functional plant.

While total floor space has only been increased by about one-third, the elimination of back-tracking and the availability of new machine tools and modern handling equipment has not only doubled the company's capacity for press manufacture, but will enable it to triple the production of its standard line of plastic injection molding presses and Hydro-Power pumps, controls and power units at plant No. 1.

The new plant was designed and built by The Austin Company and is of welded steel frame construction. Except for the compact single-story office building and the main (south) plant façade directly behind it, where buff face-brick has been used, the walls consist entirely of continuous projected steel sash in high runs, separated only by narrow bands of 4-inch corrugated asbestos. The sash and asbestos siding on the north, west and east sides of the building are merely bolted to the frame and will facilitate expansion of the plant in any of these directions without loss of materials. Hammered Aklo glass has been used throughout sash on the south and west to neutralize the effect of direct sunlight. Clear glass is used on the north and hammered glass on the east. The roof is an 18 gage steel deck which was spot-welded and has one inch cork insulation, topped by built-up roofing.

The building is 400 ft. long and has three bays. The high (north) bay, 55 ft. wide, has a 36 ft. working clearance below the hooks of two 50-ton cranes which serve this area. The intermediate bay is 40 ft. wide and affords 22 ft. working clearance below the hooks of two 15-ton cranes serving this section of the plant. All major operations in the machining and assembly of press parts take place in these bays, while the low bay, 20 ft. wide, on the south houses secondary equipment, tool cribs, light material storage, factory offices and lavatories. In designing the structural steel, provision was made for the addition of a second 40 ft. bay with craneways on the north side of the high aisle.

With production flowing from west to east, and one railroad track entering the plant at the west for delivery of large castings and other equipment, assembly and shipping are concentrated at the east end. The floor at this end is 4 ft. lower than in the main production area. This makes it possible to bring railroad cars for outgoing shipments in on the lower level.



Presses Are Here Being Assembled in the Foreground, at the East End of the Main Operating Floor in the High Craneway Aisle. The View Is Taken from the Depressed Area at the Extreme East End of the Plant. It Shows the Track Scale Which Is Recessed in the Retaining Wall

Flame Cutters and Welders Work on One Side at This End of the Intermediate Bay at The Hydraulic Press Manufacturing Company's New Plant, Where Built Up Bases Are Fabricated, Preparatory to Assembly at the Other End of the Plant

Not a Kick in a Mile of it!
CLARK KICKLESS CABLE showing 720° Torsional Hand Twist in Direction Opposite Helical Winding
CLARK KICKLESS CABLE in Normal Position—No Torsional Twist
CLARK KICKLESS CABLE showing 450° Hand Twist in Same Direction as Helical Winding

• No Sir! There's no kick in Clark Kickless Cable—a water cooled electrical connection between the secondary taps of a welder transformer and a portable welder gun. The interweaving of cables of opposite polarity around a central soft rubber core, with a corrugated live rubber spacer, causes reactances to neutralize each other. This neutralization effectively eliminates the "kick" or jerking apart that characterizes the use of two separate cables.

And this "Kickless" quality helps production... because the gun can be placed and held accurately... the operator has no "kick fatigue" to overcome... more amperage is delivered at the tips...uniform amperage is delivered at all times.

Flexible? Yes, sir! The cable diameter is sufficiently small to allow bending into arcs of short radii. The cables are helically wound, and just a simple twist of the wrist permits torsional flexion of 450° from normal in the direction of the helical winding, and 720° from normal in the direction opposite to the helical winding. (See the chalk line on the special made, cord-reinforced, rubber tube in the pictures.)

Such twisting is visible evidence that torsional pliancy and bending sufficient for practically every welder gun application are found in Clark Kickless Cable.

FURNISHED IN TWO SIZES

400 M—equivalent to separate cables of 400,000 c. m.
750 M—equivalent to separate cables of 750,000 c. m.

WRITE FOR BULLETIN 7777 FOR COMPLETE DETAILS

OFFICES IN PRINCIPAL CITIES

THE CLARK CONTROLLER CO.

1146 EAST 152ND ST. CLEVELAND, OHIO

OBITUARIES

Wilbert J. Austin

Wilbert J. Austin of Cleveland, who was among the victims in the airliner which crashed at Chicago December 4th, had been president of The Austin Company, national organization of engineers and builders, since 1924. As active head of an enterprise which designed and erected nearly 6000 industrial buildings in the United States and 23 foreign countries, Mr. Austin was known to business executives throughout the world as an advocate of functionalism in factory building.

Standardization of basic structural designs, pioneering work in the application of electric welding to heavy industrial structures, and development of the controlled conditions principles which are finding widespread application in windowless plants now being erected throughout the country, are characteristic of the contributions made by this organization under Mr. Austin's pioneering leadership.

Wilbert J. Austin

A native of Cleveland where his father, Samuel Austin, set up as a journeyman carpenter on arrival from England in 1873, Wilbert Austin was graduated from Case School of Applied Science in 1899 with a Bachelor of Science degree in Mechanical Engineering. In March 1940 this school awarded him an honorary degree of Doctor of Engineering.

In 1900, after a year's travel and study abroad, Mr. Austin joined his father who had already developed a substantial following as a builder of residential, commercial and industrial structures. He brought an engineering approach which ultimately led to the development of the idea under which Austin has planned and built plants for the country's leading industries over a period of 40 years under contracts embracing all phases of design and construction.

Noteworthy examples which characterize the evolution of Austin business are the General Electric Company buildings at Nela Park; the Caterpillar Tractor Company Works at Peoria; the Pontiac Motor plant at Pontiac; a $60,000,000 Russian industrial city for Soviet production of automobiles; Electro-Motive Corporation's all-welded diesel locomotive assembly shops; the Simonds Saw & Steel Company's controlled conditions plant; N. B. C.'s new Radio City in Hollywood; Church & Dwight Co., Inc.'s new bicarbonate of soda plant, and welded rigid frame structures for Lincoln Electric Company and many others.

Mr. Austin, 64, was a trustee of Case School of Applied Science, past-president of its alumni body and chairman of its building committee, as well as a member of the Y. M. C. A. national council. He was a member of the New York Bankers' Club, the Detroit Yacht Club, Highland (Florida) Club, the Cleveland Engineering Society, and the Union Club and Shaker Heights Country Club of Cleveland.

He is survived by his widow, the former Ida Stewart, two sons, Allan S. of Cleveland and Donald G. Austin of Houston, Texas, a daughter, Mrs. Charles G. Rodgers of Cleveland and four grandchildren.

Funeral services Saturday, December 7th, were held at the Windermere M. E. Church, East Cleveland, where Mr. Austin was chairman of the board of trustees.

Mr. Marshall Williams

Mr. Marshall Williams, one-time official of the American Bridge Company, died on December 5th, aged 67 years.

Mr. Williams was a native of New Jersey and a graduate of Rutgers College. He entered the employ of the Pencoyd Iron Works (later taken over by American Bridge Company) in 1898, and from that date he was continuously associated with the Bridge Company, retiring on June 1, 1940. During his 42-year service with that organization, he held various executive positions, and at the time of his retirement was assistant to president.

Mr. Williams was a member of the American Society of Civil Engineers, Engineers Society of Western Pennsylvania and the AMERICAN WELDING SOCIETY.

M. Keith Dunham

Mr. M. Keith Dunham, Chairman of National Cylinder Gas Company, died at his home in Montague, Michigan, September 29, 1940, as a result of a heart attack suffered in June. He had been associated with the oxyacetylene industry during the greater portion of his life and was one of the first to recognize the worth and promote the use of the oxyacetylene process.

He was born October 18, 1882, in Canada and brought to the United States at an early age. His first association with the industry was in 1908 in Boston, Massachusetts, when he started to work on the development of apparatus for use with oxygen and acetylene, and at the same time ran a job welding shop under the name of Waterhouse Welding Company.

From 1915 to 1917 he did consulting work on problems associated with the industry. During this time he also wrote many articles for trade publications and a book entitled "Automobile Welding—With the Oxy-Acetylene Flame."

In 1917 he became associated with Bastian-Blessing Company as Chief Engineer in which capacity he designed the original Rego line of welding and cutting apparatus. At this time he also developed and patented the balanced pressure principle for oxyacetylene torches. He left the Bastian-Blessing Company in 1921 to go in business under his own name selling and engineering liquefaction oxygen equipment.

In 1924 under the name of Dunham Manufacturing Company he started to manufacture monolithic-filled, dissolved-acetylene cylinders.

In 1927 the Keith Dunham Company was formed to transact business which was formerly done under his name. Keith Dunham Company was the forerunner of National Cylinder Gas Company as it now exists.

NEW SHUTTLE CAR A DISTINCT ADVANCE IN MINING EQUIPMENT

Progress in industry is nowhere more evident than in a new mining shuttle car developed by the Joy Manufacturing Co. of Franklin, Pa.

These new cars, one of which is shown in the accompanying illustration Fig. 1, afford very definite savings as compared with mine car haulage behind loading machines. Most of the savings have come about because the new machine increases the number of operating hours at the face of the mine.

In normal operation, with mine car haulage behind the loader, the loading machine operates about 36% of the time. This means that the loader is idle more than 60% of the time waiting for cars and making moves from one place to another.

In the case of the new shuttle car, the operating period of the loader has been increased to 70% of the time. This means an increase of approximately 100% in the productivity of the unit.

Two of the new shuttle cars operating behind each loader permits great flexibility of both units, which in turn makes

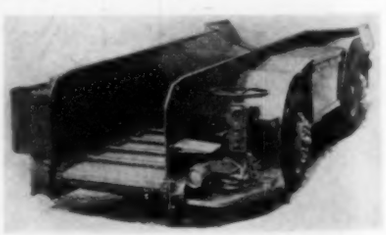


Fig. 1—New Welded-Steel Mine Shuttle Car, Manufactured by the Joy Manufacturing Co., Franklin, Pa., Which Is Said to Increase About 100%, Productivity in Loading, Hauling and Unloading

Photos courtesy Lincoln Electric Co

Fig. 2—New Welded-Steel Mine Shuttle Car in Operation

it possible for the machine and haulage system to advance simultaneously from one room to another without the expense or labor of laying track and switches, since the loading machine runs on caterpillars and the shuttle cars on rubber tires.

According to the manufacturer, the new equipment has reduced cost per ton at the main line haulage between 40% and 50%.

This new advance in mining equipment utilizes arc-welded steel construction. With the exception of bolting, which is used to attach the side members to the main frame of the car, all construction is welded steel. Bolting is used for the parts mentioned to permit dismantling the machine and taking it into the mine where it is re-assembled. The main frame is welded, also the side members and fenders, even the conveyor bars which are made of rectangular tube are of welded construction.

The shuttle car is made in $3^1/_2$-, $4^1/_2$-, 5- and 6-ton capacities. Traveling speed is $3^1/_2$ miles per hour loaded, 5 miles per hour empty. Weight of the car empty ranges between 10,800 lb. for the $3^1/_2$-ton unit to 13,200 lb. for the 6-ton model. Propulsion is by electric motor driven by power supplied from storage batteries.

Development of this new equipment is certainly a real advance in mining progress. It does away with track laying, hand or mechanical loading and separate propulsion either by mule or electric locomotive. All that is necessary now is to run this self-propelled car into the room without laying any track whatsoever, load the car from a mechanical loader, run it out to the main line and unload it.

Figure 2 shows one of the new shuttle cars in operation.

STAINLESS-SPRAYED RECONDITIONED PARTS

Spraying worn parts with stainless steel by a metallizing process and remachining to size, is producing reconditioned parts giving from 100 to 300 per cent their original service life on a well known Middle Western Railroad.

Many locomotive parts which would normally be scrapped are being reclaimed and reconditioned by this process, as well as such parts as shafts, water pump piston rods, motor armature shafts, etc.

In practice, 18-8 stainless steel for metallizing, in wire form, is fed into the back of a gun equipped with an air turbine supplying power to two knurled rolls—feeding the wire through the gun

Machining a Reclaimed Railroad Air and Water Pump Rod. Worn Parts Are Sprayed with Stainless Steel and Refinished to Size with Carboloy Tools at 242 Ft. Per Minute Cutting Speed

UNA TAPER

Converts Your Present Automatic Welding to Unamatic Protected Arc Quality—

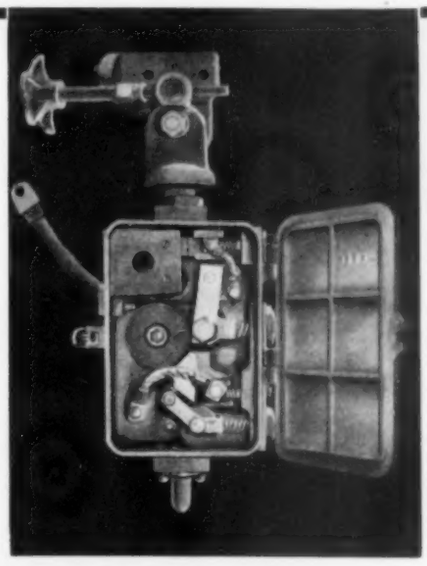
IMPROVE QUALITY • INCREASE PRODUCTION AND LOWER COSTS

When the demands for increased production and better quality create new problems of equipment and man power turn to the "Unamatic Process" for a solution.

If you have an automatic head put it to use—If you have none investigate the complete new automatic fully developed for protected arc welding.

Specializing in automatic welding for 20 years.

UNA WELDING, INC.
Cleveland, Ohio



into the center of a neutral oxyacetylene flame. By careful adjustment of the speed of the wire through this flame, a fine atomization and even deposition on the worn parts are obtained.

Prior to the spraying, all surfaces to be sprayed are sandblasted, using a 30-mesh steel angular grit, which not only thoroughly cleans, but also roughens the surface and enables the sprayed metal to adhere to it. Spraying is to a depth of $^{1}/_{64}$th to $^{1}/_{32}$nd inch per side in excess of the size to which the part is to be machined.

To obtain the fine finish desired, it was found desirable to turn such sprayed metal finishes at high speeds—from 200 to 450 ft. per minute—with fine cuts and a slow feed. On parts that cannot be turned, the surfaces are finished by grinding from the rough.

A typical part—an air and water pump rod—is shown being re-machined on a 20-inch lathe in the accompanying photograph. Cutting speed in this case is 242 ft. per minute, with a $^{1}/_{64}$-inch depth of cut and 0.005-inch feed. Floor to floor time for this 2-ft. long $1^{3}/_{4}$ inch diameter shaft is 20 minutes, with approximately 12 pieces being machined per grind of the Carboloy tool.

NEW TYPE WATER MIXING CHAMBER AND SETTLING TANK IS WELDED

A new type of water mixing chamber and settling tank of all-steel construction was recently completed for a water company in western Pennsylvania by Marion Machine Foundry & Supply Company, Scottdale, Pa. It is shown during construction in the accompanying illustration.

The new design employed for this filtration plant is one which places the mixing chamber in the center of the settling basin. This is in contrast to the conventional method of employing two separate units—a mixing chamber and a settling basin.

The raw water is pumped into the center unit where it flows up and down between baffles, starting at the bottom of the center mixing chamber. A high-pressure line adds sulphate of iron and lime to the raw water before it enters the mixing chamber. Trash gates of welded steel construction are located at the entrance of the intake to prevent passage of heavy refuse.

After passing from the mixing chamber through its many baffles, the water passes into the outer settling tank and is withdrawn from there for further treatment and purification by conventional methods.

The entire plant consists of a series of six tanks of 5 feet, 14 feet, 23 feet, 32 feet, 69 feet and 93 feet diameters, set one inside of the other as shown. They are 17 feet high. The outer tank of 93 feet diameter is built from $^{5}/_{16}$-inch plate, the remainder of the tanks are all $^{1}/_{4}$-inch plate. All welding was done with Shielded-Arc electrodes. About 10% of the welding was done in the plant of the contractor and the balance in the field. There is a total of 241,000 pounds of plates, angles, channels and beams in the project with a total weld footage of 6475 feet.

All joints were straight butt joints with the exception of those in the outer ring which were lap joints. All joints were welded inside and outside. After completion, the tank was given one coat of red oxide and one coat of aluminum paint on the outside, and one coat of primer and one coat of gray water proofing paint on all inside surfaces.

NEW OXYGRAPH-TRAVOGRAPH GAS CUTTING MACHINE BULLETIN

The 24-page bulletin featuring the No. 6-A Oxygraph and the Nos. 10, 40 and 41 Travographs has just been published by Air Reduction, New York. These machines will cut an unlimited variety of shapes from steel plate, slabs, billets and forgings. Pages 4 to 13 in this interesting booklet are devoted to excellent examples of the "Visible Evidence of the Scope and Cost-Paring Possibilities" of this group of Airco Gas Cutting Machines.

All operate on the pantograph principle so that one or several cutting torches are made to conform exactly to the movement of the tracing device. The second half of the book is devoted to an individual treatment of each of the machines discussed therein. Features of construction and operation are discussed in detail, standard equipment and electrical requirements are listed. The last two pages are devoted to an interesting treatise giving many helpful hints for machine gas cutting. This material includes an approximate guide for Airco machine gas cutting, with suggested tip sizes, oxygen and acetylene pressures, cutting speed in inches per minute and approximate gas consumption.

Additional information and a copy and bulletin may be obtained by writing Air Reduction, 60 East 42nd St., New York.

Photo courtesy Lincoln Electric Company

New Type Water Mixing Chamber and Settling Tank of Welded Steel Construction

PAINLESS DENTAL WORK

Equipment breakdowns are a big headache and, if not quickly taken care of, really "hurt" the pocketbook.

Photo courtesy R. G. Le Tourneau, Inc., Peoria, Ill.

A number of equipment dealers and large contractors have met this important repair and maintenance problem with panel trucks equipped with portable welders.

The photograph shows a service man for the J. D. Pittman Tractor Company repairing the giant "molars" of a shovel dipper near Ft. Payne, Alabama, quickly and properly on the job.

"MIDGET MARVEL" A.C. WELDER

A new four page illustrated bulletin which describes the construction and operational features of the "Midget Marvel Flexarc" a.c. welder is announced by the Westinghouse Electric & Manufacturing Company. Contained in the bulletin are pictures of the welder with its outstanding features pointed out and explained. Internal construction is discussed and illustrated.

A comprehensive and informative list of applications gives the reader a lead as to the applications of a.c. welding in both commercial and industrial fields. Operation costs are discussed, and a graphic chart gives power costs on the "Midget Marvel" in cents per hour of operation.

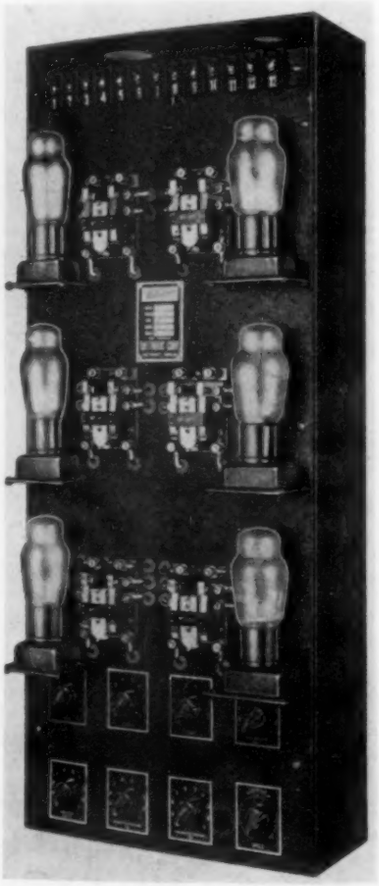
Copies of descriptive data 26-320 may be obtained upon request from department 7-N-20, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

NEW PRODUCTS

The Society assumes no responsibility for the validity of claims in this Section

TIMING RESISTANCE FORGE WELDING

The recently announced process of Resistance Forge Welding which permits the spot welding of heavy iron and steel sections and which requires a complicated sequence of accurately timed operations is made possible through a specially designed Weltronic welding timer of the electronic type.



Designed and built by Weltronic Corporation, 2832 East Grand Blvd., Detroit, the timer is capable of providing accurate timing control for the various operating sequences required for the process, which are: low weld current; high weld current; initial (low) welding pressure; impact forging (high) pressure; cool time; hold time; etc. In addition, the timer is designed to time virtually any combination of functions required in spot welding heavy sections within the scope of the resistance forge welding process and can be used with any equipment capable of handling such work, whether standard or special.

SPOT WELDING SIMILAR AND DISSIMILAR METALS

In order to assist in solving the various spot welding problems which may turn up from time to time, a recommendation chart has recently been approved by the Resistance Welder Manufacturers' Association.

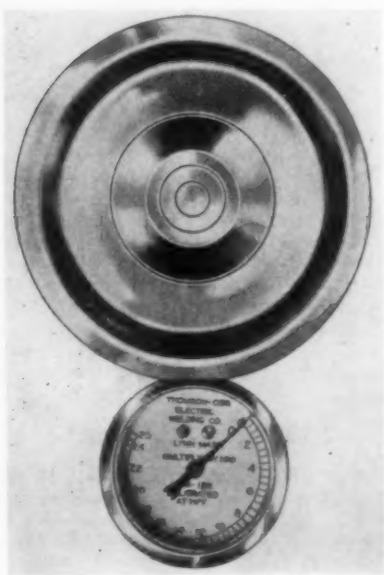
This chart is the result of extensive laboratory and shop tests, and embodies the best general recommendations which can be made for the selection of proper electrode materials for spot welding the similar and dissimilar metals outlined.

This chart has been published by the P. R. Mallory & Co., Inc. with special reference to the Mallory electrodes. Copy may be obtained from P. R. Mallory & Co., Inc., Indianapolis, Ind.

IMPROVED THOMSON PRESSURE METER

Important improvements in the design of this Thomson Resistance Welding Pressure Meter insure more accurate readings and guarantee lasting accuracy of the instrument. The meter consists of an oil-filled diaphragm connected to a gage made with a bronze bushed movement. The dial is calibrated to read directly in pounds and each gage is individually calibrated on an Olsen testing machine. When completely assembled, each meter is given a final working test before being packed for shipment.

These pressure gages are available in the following ranges: 0–350, 0–550, 0–800, 0–1600, 0–2500, 0–4000, 0–5000 and 0–8000 pounds. The gages are chromium plated, have beveled glass faces and are individually packed in stout wooden boxes designed to protect the gage when not in use.



SPOT AND PROJECTION WELDERS

A complete line of direct-action, air-operated Press Type Spot and Projection Welders is announced by the Acme Electric Welder Company, 5621 Pacific Blvd., Huntington Park, Calif., and fully described in their new Bulletin No. 53.

This line of air-operated spot welders is manufactured in transformer capacities from 30 kva. to 150 kva. In the smaller capacity welders throat depths are available from 12 to 30 inches, and in the larger capacity welders from 12 to 48 inches. Eight steps of heat regulation are standard but up to 32 steps can be supplied on special order.

The all-welded fabricated-steel construction of the welder bases not only provides extreme rigidity and sturdiness, but a particularly modern and streamlined appearance.

HIGH-TEST FLUX-COATED BRONZE WELDING RODS AND FLUX FOR BARE RODS

An outstanding new High-Test Flux-Coated Bronze Welding Rod has recently been announced by Air Reduction, New York. It offers eight outstanding advantages for bronze welding operations: (1) Low fuming, (2) applies faster, (3) denser deposit, (4) increased tensile strength, (5) greater bond strength, (6) increased hardness of deposit, (7) materially improved ductility, (8) time saving.

Each of these qualities is an asset that every experienced buyer will appreciate. Time formerly lost in removing a bare rod

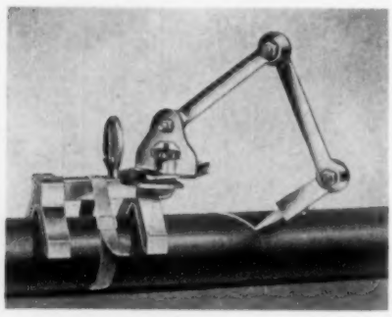
from the molten puddle and dipping it into a flux can is time saved when Airco High-Test Flux-Coated Bronze Welding Rods are used. The flux adheres splendidly in shipment and in use. It will not fall off when the rod is excessively bent.

For those who prefer a bare welding rod, the same outstanding flux is available in a liquid-paste form.

For full information and descriptive literature write Air Reduction, 60 East 42nd Street, New York, N. Y.

PIPE PROTRACTOR

The Trumark Junior Protractor, for marking layouts at any angle on rods or pipe up to 3 inches, rectangular forms, sheet metal, channels or T shapes, or flat surfaces has been recently introduced by the Tru-Line Corporation, 6022 Wilshire Blvd., Los Angeles, California.



This instrument makes possible instant markings for cutting, shearing, sawing or machining.

Time and material are saved by this quick and accurate marking device in many divisions of industry, including aircraft plants, machine shops, sheet-metal shops, shipyards, railroad shops and public utilities, pipeline contractors and industrial welders.

2500-POUND CAPACITY WELDING POSITIONER

A new Welding Positioner for positioning pieces weighing up to 2500 pounds has just been announced by the Ransome Concrete Machinery Company, Dunellen, N. J. Designed to facilitate the handling of material in welding shops, the machine is claimed by the manufacturer to substantially reduce welding costs and simultaneously speed up production.

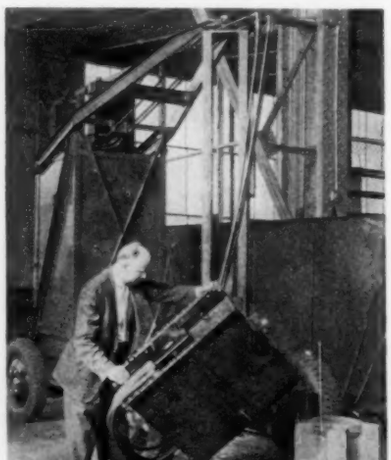
The all-welded table top, with T-slots for easy clamping, revolves a full 360 degrees and tilts 135 degrees beyond horizontal. A worm and worm wheel arrangement makes the table self-locking when handling unbalanced loads. The machine is available with hand wheels for manual operation or with tilting and revolving motors with remote control push buttons.

A new bulletin, No. 172, illustrating and describing the new positioner is just off the press. Well illustrated and containing interesting information on position welding, the bulletin is available by addressing the Ransome Company.

TRUCK-MOUNTED X-RAY MACHINE

To check the perfection of castings and welded parts which go into products of the Erie Works of the General Electric Company, the industrial X-ray equipment shown here is used. With this equipment, the "innards" of castings or other metal parts are radiographed before machining operations are started in order to detect any concealed flaws in the metal. This equipment is useful in the investigation of materials used in products such as armature and commutator spiders and various fabricated parts.

The equipment pictured is a G-E X-ray Corporation Model OX-220 on mobile truck-type mounting and rated at 75 to 220 kilovolts peak at 10 ma. It is completely shockproof, all high voltage equip-



ment including X-ray tube and high voltage transformer being oil-immersed in a grounded metal case. The control panel is mounted in a lead-lined booth at the rear of the truck to protect the operator from continual exposure to the X-rays. The machine weighs 7000 pounds and its rays will penetrate about $3\frac{1}{2}$ inches in steel.

SAFETY GOGGLE LENS

In an actual welding service test, the Tulca Safety lens was unaffected by flying particles of hot metal and sparks after 84 hours of service. The ordinary tempered glass lens was so "pitted" after 16 hours, that it was unfit for further use. The Tulca lens is made of a newly developed, non-shattering material and is not to be confused with old type plastic or liminated safety lenses. Made by Univis Lens Co., Dayton, Ohio.

ALUMINUM BRONZE ROD

Ampco Metal, Inc., Milwaukee, Wis., announces that aluminum bronze in the form of a coated weldrod is now being produced for the first time. The usefulness of the aluminum bronze alloys, with their properties of wear resistance, high strength, hardness and resistance to fatigue and corrosion, is thus extended to meet the demand for such a material.

Tests reveal the following physical properties of "Ampco-Weld," aluminum bronze weldrod, as compared with older bronze welding materials. Note the higher Rockwell figures obtainable on the new material:

Weld Material	Rockwell (B Scale)	Ult. Str., Psi	Elong., % in 2 Inches
*Grade 12 Ampco-Weld	63	61,500	24.5
*Grade 16 Ampco-Weld	79	87,000	16.0
*Grade 18 Ampco-Weld	89	92,500	12.5
*Grade 20 Ampco-Weld	94	76,500	8.5
*Grade 21 Ampco-Weld	29†	79,500	4.5
*Grade 22 Ampco-Weld	38†	96,000	0.5

* Actual test bar of all-weld metal.
† On C Scale.

The accompanying photograph, shows a standard 0.505-inch test bar turned of S. A. E. 1021 steel, with a V-notch weld of Grade 18 "Ampco-Weld." This bar broke after 27% elongation in a 2-inch gage length, at 84,000 psi. Note that the steel elongated on both sides of the weld section and necked down before fracture. The weld material, however, still retains its original diameter under the micrometer with little apparent elongation.

"Ampco-Weld" is being used for rebuilding worn cams, gears, dies and bearing surfaces, as well as in original work where the bearing properties and corrosion resistance of the metal can be used to advantage.

HEATING TORCHES

The Bastian-Blessing Company have taken over the distribution of the Forster Torch Line manufactured by Ransome Company for the entire United States east of the Rocky Mountains.

Forster Torches are designed especially for use with butane and propane gases and they are well known to the liquefied petroleum gas industry. Their use for heating, metal working, soldering, paint burning, lead melting, etc., offers another profitable outlet for butane and propane gases for industrial purposes.

WELDING HELMET

A welding helmet from which the glass can be removed and inserted from the outside in a few seconds and with head band that may be adjusted on the head without removing gloves is announced by The Boyer Campbell Company, 6540 Antoine St., Detroit, Mich.

The glass is held in a non-metallic holder that has a slot in one end and a flat bowed spring between the inner cover and filter glass holds the complete assembly within the helmet. The slot through which all of the glass must pass is inside of the helmet except when glass is being inserted or replaced. At this time the holder is moved outward, just enough to allow the glass to be inserted through the slot from the outside. When replacement of glass is complete and the spring released it snaps back in the retracted position.

A.-C. ROD

Metal & Thermit Corporation, 120 Broadway, New York, N. Y., announces an addition to its line of Murex-covered electrodes for manual arc welding. The new electrode, known as Murex Alternex, is designed especially for use with transformer type A. C. welding equipment and is said to handle extremely well in all positions, including "vertical-down-welding." In the smaller sizes, it may also be used to advantage in welding light-gage steel.

PLANOGRAPH BULLETIN

The Airco No. 10 Planograph, a new 8-page bulletin published by Air Reduction Sales Co., New York, describes this gas-operated cutting machine designed for cutting straight lines, rectangles, circles and irregular shapes from ferrous metal of any thickness within the present practical limits of the cutting torch.

The bulletin contains a complete pictorial representation of the Planograph, as well as operating details and specifications. Features of the device are listed, such as its wide cutting range, single or two-torch operation, centralized location of electrical controls, interchangeable devices for manual tracing or magnetic and templet tracing, and central gas control unit.

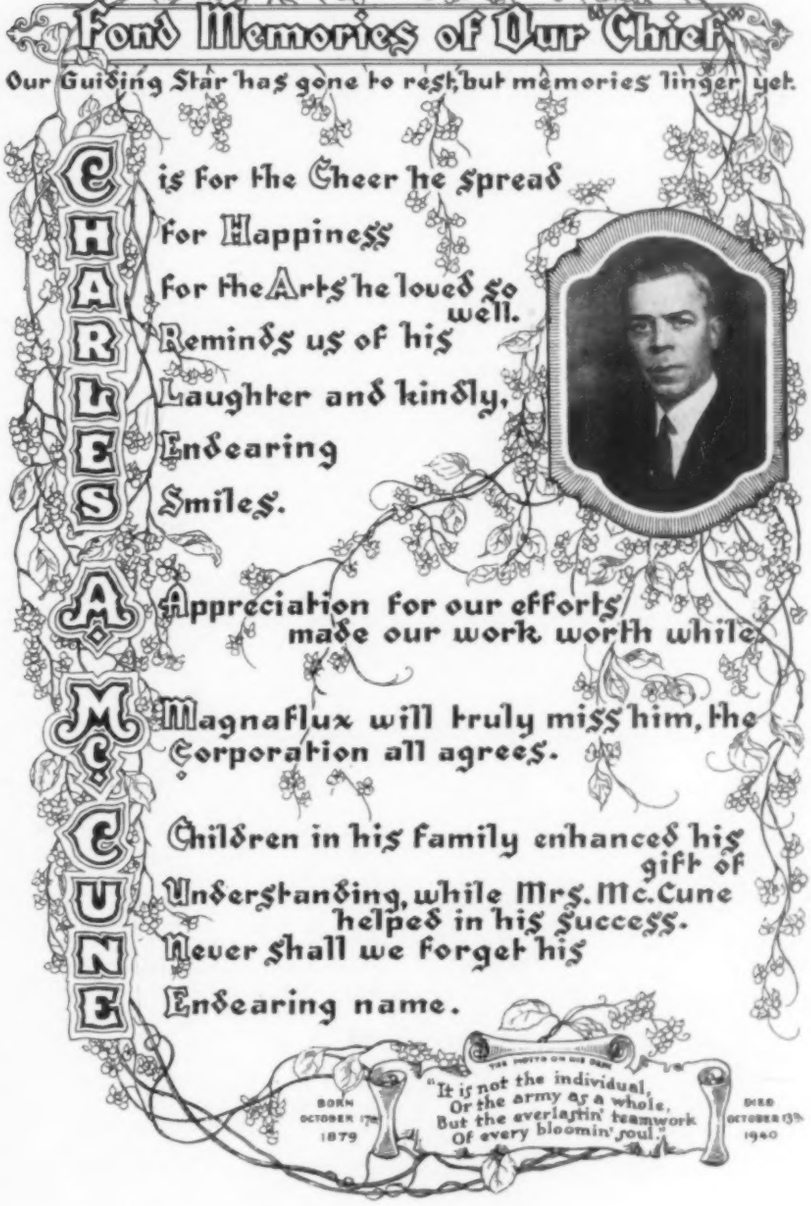
Copies of this bulletin may be obtained by writing Air Reduction Sales Co., 60 East 42nd Street, New York, N. Y.

BOUND VOLUME JOURNAL

The AMERICAN WELDING SOCIETY has made arrangements for members who wish to have their Journals for 1940 bound in attractive, imitation black leather covers, to do so by sending copies of the twelve issues to Russell-Rutter Company, Thirty-Third Street and Eighth Avenue, New York, N. Y., Att. Mr. Russell Lauben, Jr. A special reduced rate has been arranged at $1.75 per volume providing the issues of the JOURNAL are sent to the binder on or before February 10th. The bill for the binding and return postage will be sent direct from the Society's office.

CHARLES A. McCUNE

The testimonial shown below is reproduced through the courtesy of the Magnaflux Corporation.



SECTION ACTIVITIES

BIRMINGHAM

Newly elected officers of the Birmingham Section for 1940-41 are as follows: *Chairman*, C. R. Tinsley, U. S. Pipe & Foundry Co.; *Vice-Chairman*, F. E. McAtee, Chicago Bridge & Iron Co.; *Sec.-Treas.*, W. L. Poole, Air Reduction Sales Company. *Executive Committee:* (term expires May 1941), E. E. Michaels, J. E. Durstine, J. B. McCaghren, C. E. Korner; (term expires May 1942) W. C. Sleeman, R. E. Jones, Sr., Paul Wright, Julian W. Adams.

BOSTON

The first meeting of the season was held at Massachusetts Institute of Technology on October 14th, at which time Professor P. E. Kyle spoke on the Metallurgy of Welding. In his discussion, Professor Kyle used a method he had developed of the micro-projection of chemical substances as they solidify from the melt, to explain how metals behave on cooling, and to show how a weld solidifies.

The Boston Section was well represented at the Annual Meeting of the AMERICAN WELDING SOCIETY in Cleveland during the National Metal Congress and Exposition, held from October 20th to October 26th. The following members were present: P. J. Horgan, newly elected District Vice-President; F. B. Mehaffey, Chairman; P. L. F. Feyling, Vice-Chairman; P. N. Rugg, Secretary, F. W. Davis, Chairman, Meetings and Papers Committee; Prof. P. E. Kyle; E. D. Debes; T. D. Parsons.

CANAL ZONE

A new Section of the AMERICAN WELDING SOCIETY known as the Canal Zone Section was organized on August 14, 1940, with the following officers: *Chairman*, R. E. Hollick, Ancon, C. Z.; *Vice-Chairman*, Wm. M. Galloway, Diablo Heights, C. Z.; *Sec.-Treas.*, James G. Murray, P. O. Box 623, Diablo Heights, C. Z.

CHATTANOOGA

New Secretary-Treasurer of the Chattanooga Section is Mr. M. T. Glenn of 242 Oak Street, Chattanooga, Tenn.

CINCINNATI

The Cincinnati Chapter held their regular monthly meeting Tuesday, October 15th, at the Electrical High School, Cincinnati, Ohio.

The subject for the evening was "Oxy-acetylene Welding" which was discussed by Mr. A. N. Kugler, of Air Reduction Sales Company, and demonstrated by Val Forgett, also of Air Reduction Sales Company. Both the discussion and the demonstration were very instructive and interesting.

It was the opinion of those present that Mr. Forgett did an extra fine job of demonstrating the use of oxyacetylene torch-type welding.

The meeting was attended by members of AMERICAN WELDING SOCIETY as well as heating, piping and air conditioning contractors of Cincinnati association. The total attendance for the evening was 103.

The November meeting was held on the 14th. Mr. Frank Flocke, Director of Technical Research and Welding of The International Nickel Company, lectured on "Fabricating of Monel, Nickel and Inconel Solid Plate and Clad-Plate Construction." This lecture was illustrated by slides.

The meeting was enjoyed by about 60 members of the local Section of the Society, in addition to visiting engineers from other technical societies.

CLEVELAND

The Cleveland Section has approached and passed the two hundred mark in membership and is next working toward the 250 milestone.

On Wednesday, December 11th, Mr. J. Lyell Wilson, of American Bureau of Shipping, gave a very well-received talk entitled "Welding in the Shipbuilding Industry." About one hundred fifty of the welding community especially interested in the greater use of welding for Great Lakes marine construction and repair gave Mr. Lyell an attentive ear judging from the enthusiastic discussion that followed the talk.

The "surprise" meeting being held in January has been arranged by E. B. Williams, of American Shipbuilding Co., to give A. W. S. men an insight into some of the processes they use every day and to point out some of the newer processes that compete with and work hand in hand with welding.

The Cleveland Section Educational lecture course this year starts early in January Mr. Carson of Case School of Applied Science has arranged the course under the leadership of several of the faculty of Case School as shown below. A laboratory fee of $1.00 will be charged all members and affiliates, and a general fee of $3.50 is being charged non-members who desire to take the course.

This course will be divided into four lectures and two laboratory sessions. Each subject will be handled by a different instructor.

The lectures will start promptly at 7:30 o'clock and will continue for one hour. All lectures with the exception of the third and the last will be held in Room 10, Bingham Mechanical Eng. Bldg., Case School. The subjects to be covered are:

January 14, 1941—"Terminology and Nomenclature," Professor H. D. Churchill.

January 21, 1941—"The Elements of Metallurgy as Applied to Welding," Professor G. M. Cover.

January 28, 1941—(in Warner Materials Testing Laboratory), "Determination of Physical Properties of Material," Prof. H. D. Churchill.

February 4, 1941—"Elements of Welding Design as Applied to Structures," Prof. M. S. Ketchum.

February 11, 1941—"Photo-Elastic Method of Stress Analysis," Prof. R. R. Slaymaker.

February 18, 1941—(in X-Ray Laboratory, Metallurgical Eng. Bldg.), "Indestructible Methods of Testing Welds."

COLUMBUS

Mr. Charles H. Jennings, of the Westinghouse Electric & Mfg. Co., spoke at the November 8th meeting of the Columbus Section on the subject, "Progress and Application of Welding in Foreign Countries."

Mr. C. H. Jackman, of the Carnegie-Illinois Steel Co., spoke at the December 13th meeting on the subject, "Fabrication of Low Alloy Steels."

The following are the newly elected officers for the fiscal year: *Chairman*, J. A. Foust, Ohio State University; *Vice-Chairman*, F. B. Dahle, Battelle Memorial Institute; *Sec.-Treas.*, Geo. S. Herren, Seagrave Corp.

DETROIT

Mr. J. B. Manor, of the Weldit Acetylene Co., addressed the November 1st meeting of the Detroit Section on the subject, "Safety in the Use of Oxygen and Acetylene," which was very well received by an audience of about 175 people.

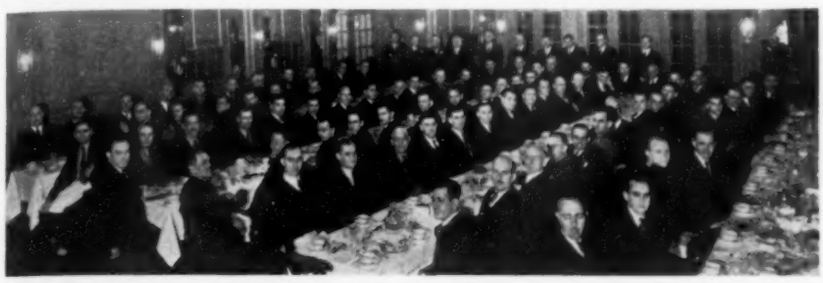
Mr. B. L. Wise, Chief Electrical Engineer of the Federal Machine & Welder Co., presented a timely and interesting address on "Possibilities of Resistance Welding in the National Defense Program," at the December 6th meeting. Among the subjects covered by Mr. Wise were: Welding of brass sheets and subsequently deep drawing of welded sheets; welding of aluminum using "stored energy" or "condenser discharge" method; adopting automotive procedures to fabrication of defense parts as shells, bombs, etc.

INDIANA

Secretary G. E. Haislup has found it necessary to discontinue his A. W. S. activities due to the press of other duties. Mr. E. F. Gilyeat, Jr., welding engineer, J. D. Adams Manufacturing Co., 217 So. Belmont Ave., Indianapolis, has taken over the duties as Secretary.

KANSAS CITY

Mr. J. F. Lincoln, President of The Lincoln Electric Co., gave an illustrated talk on "Welding Profits *versus* Prejudice" at the November 12th dinner meeting at which there were about 100 present. Mr. Lincoln's talk was followed by a very interesting discussion of the welding problems of today, new developments, etc. A picture taken at the dinner is shown herewith.



MARYLAND

Mr. J. B. Hendrickson, of Welding Engineers, Inc., of Philadelphia, will speak on the subject of "Problems of a Contract Welder" at the January 17th meeting of the Maryland Section.

Mr. A. L. Penniman, Gen. Supt. of Electrical Operations of the Consolidated Gas, Electric Light & Power Co. of Baltimore, will present a talk on "Horse Sense in the Welding Game" at the February 21st meeting.

MILWAUKEE

The regular monthly meeting of the Milwaukee Section we held on November 15th at a new meeting place, the Stratford Arms, 1404 W. Wisconsin Ave. An after-dinner talk was given by Messrs. J. G. Dickinson and William Hackbarth, of The Milwaukee Electric Railway & Transport Company, on "Transportation Safety Depends on Training." The welding address was given by Dr. W. A. Pearl, of Armour Institute of Technology, on "Weld Zone—Pre- and Post-Welding Stresses."

NEW YORK

The regular November meeting of the New York Section was held November 12, 1940, in the auditorium of the Engineering Societies' Building. This was a joint technical session of the Metropolitan Section of American Society of Mechanical Engineers and the New York Section of the AMERICAN WELDING SOCIETY, and two papers were presented dealing with the fabrication of machinery by means of cutting and welding processes.

Chairman J. T. Phillips introduced as chairman of the evening Mr. John Haydock, Managing Editor of the *American Machinist*, who conducted the technical program in a very able manner.

The first speaker was Mr. W. Roy Widdoes, General Manager of the By-Products Steel Corporation, Coatesville, Pa., who gave an interesting talk on "Machine Flame Cutting in Preparation for Welding" and concluded with very excellent motion pictures in technicolor illustrating the work done by his company.

Mr. J. H. Cooper, Welding Engineer of the Taylor-Winfield Corporation, Warren, Ohio, delivered the second paper entitled "Fabrication of Machine Tools by Welding and Gas Cutting." This paper was also lavishly illustrated by instructive motion pictures.

In spite of unfavorable weather an audience of one hundred fifty attended the meeting and felt fully repaid by the opportunity to obtain valuable information on the remarkable work done by the two companies whose representatives showed such thorough knowledge of their subjects.

NORTHERN NEW JERSEY

Mr. Harry Boardman, Research Engineer of the Chicago Bridge & Iron Co., was the principal speaker at the November 19th meeting of the Northern New Jersey Section. Illustrating his talk with a large collection of lantern slides, Mr. Boardman traced the history of the field welding of large storage tanks from its beginning to the present. Included in the talk was a fund of interesting data on present-day practices in design, inspection and the qualification of operators. Preceding Mr. Boardman's talk, Carnegie-Illinois Steel Corp. showed a two-reel film on the making and shaping of steel. Eighty-four members and guests attended the dinner, which is held each month at the Essex House in Newark just before the meeting, and about 260 were present when the meeting was called to order. After the meeting was over the Membership Committee reported that twelve new memberships had been secured in the course of the evening.

The date of the regular December meeting of the Section was advanced from the 17th to the 10th in order to avoid having the date of the meeting too near the holiday season. The meeting took the form of a forum for discussion of questions on welding subjects. A number of questions covering a wide variety of weldng methods and applications were submitted in advance of the meeting and these questions were presented to a "Board of Experts" consisting of: A. J. Ely, Standard Oil Co.; W. D. Halsey, Hartford Steam Boiler Inspection and Insurance Co.; J. T. Phillips, Foster Wheeler Corp.; M. F. Sheely, Standard Oil Development Co.; R. Vincent, Steel and Alloy Tank Co.; J. J. Vreeland, Chase Brass & Copper Co.; H. V. Inskeep, The Linde Air Products Co.

The procedure followed was to submit the questions first to one of the Experts. Additional comments were then solicited from other members of the Board, and finally questions and comments were invited from the floor. Mr. Alexander Kidd, of M. W. Kellogg Co., who is Chairman of the Program Committee of the Section, acted as Master of Ceremonies and kept the discussion at a pleasant tempo throughout the evening. The Experts were notified that they could voice their individual opinions freely and that such opinions would not be considered as representing the views of their organizations. The result was a lively and valuable discussion of numerous questions, all of which seemed to have real points in them. The audience, numbering about 150 men, were astonished at the facility and precision with which the Experts came back with answers to questions which were given to them without opportunity for study.

The Section has made plans to sponsor a welding exhibit on Friday and Saturday, March 21 and 22, 1941. This will follow the pattern of industrial exhibitions consisting of exhibits and demonstrations of welding equipment, welding supplies and welding products. The exhibit will be held in the basement of the Mosque Theater in Newark, N. J., and it is planned to follow it with a banquet on Saturday evening, March 22nd. Floor plans and all details concerning arrangements for exhibits will be available for manufacturers in the near future. The Chairman of the Exhibit Committee is Mr. W. H. Hart of Charles W. Krieg Co., Newark, N. J. The purpose of this exhibit is to give welding operators and welding executives the opportunity to view a group showing of the latest developments in welding materials and welding procedures.

NORTHWEST

The October and November meetings of this Section were unusually well attended undoubtedly because two excellent speakers were scheduled, who discussed questions of immediate interest.

October 10th, A. N. Kugler, Mechanical Engineer, Applied Engineering Department, Air Reduction Sales Company, New York, presented a most interesting paper on the subject of "Oxyacetylene Welding Practice," which was illustrated by lantern slides and motion pictures.

November 7th, Louis J. Larson, Consulting Welding Engineer, Milwaukee, Wis., gave a very practical and valuable talk upon "The Mechanics of the Arc," the important points being illustrated by sketches on a blackboard.

The Section is most fortunate in having been able to get off to a good start on the season's program, and if the first meetings

of the year are an indication of those that will follow, our members will be well rewarded for the membership in the Section.

The Advisory Committee, consisting of C. E. Comfort, St. Paul Structural Steel Co., Chairman; C. M. Akins, Marquette Manufacturing Co.; Louis T. Kenny, Kenny Boiler & Mfg. Co.; and T. J. Warmington, Wm. Bros. Boiler & Mfg. Co., will be in charge of the educational course for the present season. Announcement will be made shortly of the subjects to be considered and the speakers who will present them.

OKLAHOMA CITY

Mr. James F. Lincoln, President of The Lincoln Electric Company, was the guest speaker at the November 14th meeting of the Oklahoma City Section. Mr. Lincoln's subject was on "Welding Profits *versus* Prejudice," which was illustrated with slides and well received.

Mr. Howard Miller, of the Alloy Steel Division of Republic Steel Corporation, addressed the December 5th meeting on the subject, "Welding in the National Defense Program." Black, Sivalls & Bryson, Inc., showed a colored movie of operations in their shop.

Meetings scheduled for the remainder of the season are as follows:

Jan. 16, 1941, 8:00 P.M.—"Recent Development in Oxyacetylene Practices," by Frank Hutchinson, The Linde Air Products Co.

Feb. 6, 1941, Dinner Meeting, 6:30 P.M.—"Heat and Mechanical Stresses in Welding." "The Forming of Heads for Pressure Vessels," Mr. W. G. Theisinger, Lukens Steel Co., Coatesville, Pa.

Mar. 6, 1941, 8:00 P.M.—"Spot and Resistance Welding," Mr. John D. Gordon, The Taylor-Winfield Corp., Warren, Ohio.

Apr. 10, 1941, Dinner Meeting, 6:30 P.M.—"Procedure Control of Welding," Mr. Orville T. Barnett, Metal & Thermit Corp., New York.

May 8, 1941, 8:00 P.M.—"Hard Surfacing," Mr. E. F. Smith, Haynes Stellite Co., Kokomo, Indiana.

June (to be announced)—"Résumé of Year and Report of Officers." Refreshments.

PHILADELPHIA

Mr. J. E. Waugh, of the General Electric Company, presented an interesting address on the subject, "Design of Welded Structures," at the November 18th meeting of the Philadelphia Section.

The following are the plans for the meetings for the first half of 1941:

January 20th—"Arc Welding in Small Ship Construction," Mr. J. Murray Watts, Consulting Engineer and Naval Architect.

February 17th—"The Unionmelt Welding Process and Its Industrial Application," Mr. F. G. Outcalt, The Linde Air Products Co.

March 17th—"Building Construction by Welding" Section Round Table Discussion. Mr. H. W. Lawson, Bethlehem Steel Co.

April 21st—Tentative—Railroad Application of Arc Welding.

May—Section Inspection Trip.

PITTSBURGH

Nearly one hundred members and guests attended the November 13th meeting of the Pittsburgh Section to hear Dr. W. A. Mudge and Mr. Frank Flocke discuss the manufacture, fabrication, properties and uses of non-ferrous alloys, nickel and high-nickel, as well as the nickel, Monel and Inconel-clad steels.

To illustrate their lectures both slides and a sound film entitled "Nickel Highlights" were shown. Several plate samples showing methods of cladding steel were put on display and proved very interesting.

Following the lectures, the meeting was thrown open for general discussion and all questions were satisfactorily answered by the speakers.

PUGET SOUND

The regular dinner meeting of the Puget Sound Section was held on November 18th in the Engineers' Club Rooms, Seattle. Lt.-Commdr. W. R. Dowd, U. S. N., Ship Supt. of the Puget Sound Navy Yard, spoke on the subject, "Some Practical Aspects of Welding on Ships."

QUAD CITIES

More than 200 people attended the November 12th meeting of the Quad Cities Section held in Moline, Illinois, to hear Colonel G. F. Jenks of the Office of Chief of Ordnance, Washington, D. C., and President of the AMERICAN WELDING SOCIETY, who was on a tour of the West, taking him to Rock Island Arsenal. Some guests came as far as 50 miles to attend the meeting. There were many visitors from the local industries as well as a large group from Rock Island Arsenal. Brig. Gen. N. F. Ramsey, Commander Rock Island Arsenal, introduced the speaker.

ROCHESTER

A joint meeting of the Rochester Section of the A. W. S. and the American Society for Metals was held on November 11th. Mr. Carl de Ganahl, Vice-President of Fleetwings, Inc., spoke on the subject, "Stainless Steel in Aircrafts—and the Possible Application of 'Shot' Welding of Stainless Aircraft." Lantern slides showing the trend and various examples of the subject were shown.

The December meeting was held on the 5th. Mr. J. T. Phillips, Supt. of Boiler Shop, Foster Wheeler Corporation, was the speaker of the evening. His subject was on "Welding of Pressure Vessels." Mr. Phillips discussed the effect of design on welding and showed shop views of work in progress.

ST. LOUIS

Mr. F. H. Frankland, Chief Engineer of the American Institute of Steel Construction, spoke at the November 8th meeting of the St. Louis Section. Mr. Frankland's subject was on "Trends in Design and Fabrication of Welded Structural Steels."

Mr. F. C. Fantz, Vice-President of Midwest Piping and Supply Co., was the speaker at the December 13th meeting. Mr. Fantz spoke on "What's New in High-Pressure Welding?"

SAN FRANCISCO

The October meeting was postponed until November 6th in order that the Section could take advantage of securing a speaker from the East, Mr. Leo Edelson of Handy & Harman, New York, who spoke on "Silver Brazing Alloys in Industry."

TULSA

Mr. J. F. Lincoln, President of The Lincoln Electric Company, was the guest speaker at the November 15th meeting of the Tulsa Section. A special invitation to attend the meeting was extended to the members of the Engineers' Club of Tulsa, fabricators of welded products and welding schools.

Mr. Howard Miller, of the Republic Steel Corporation, spoke on the subject of Welding in the National Defense Program, at the December 6th meeting.

WASHINGTON, D. C.

The second regular meeting of the Washington Section was held in the Auditorium of the Potomac Electric Power Company at 8 P.M. on November 26th. Chairman Trexel read a letter from the Washington Chapter of the American Society for Metals announcing the first George K. Burgess Memorial Lecture to be held on February 10th. This Memorial Lecture will be continued annually in honor of Dr. Burgess, who was outstanding as a member of the Washington Chapter. Dr. P. D. Merica, Vice-President of the International Nickel Company, will be the speaker. Dr. Merica formerly worked with Dr. Burgess at the U. S. National Bureau of Standards.

The speaker of the evening was Mr. A. Amirikian, Senior Design Engineer, Bureau of Yards and Docks, Navy Department, who presented a brief of his paper entitled "Welded Rigid Frame Structures." This paper was published in the October 1940 issue of THE WELDING JOURNAL and was presented at the 1940 annual meeting in Cleveland.

WESTERN NEW YORK

The dinner meeting, held October 18, 1940, was well attended. The address on "The Welding of Low Alloy Steels," delivered by Mr. A. E. Gibson, President of the Wellman Engineering Company of Cleveland, Ohio, was thoroughly enjoyed by the one hundred and ten members and guests present.

The regular monthly meeting of the Western New York Section was held November 15th in the Electric Building Auditorium at 8:00 P.M.

The speaker was Mr. C. J. Holslag, President of the Electric Arc Cutting and Welding Company of Newark, N. J., who talked on the subject of "Metallic Arc Welding Now and Yesterday."

As a specialist on A.C. welding and coated electrodes, Mr. Holslag's address was highly informative from the standpoint of practical application.

In the drive to increase membership, each member has been allotted a quota of two members to be obtained during the current season. Already several members have exceeded this quota, and substantial membership gains will be recorded in the future.

WICHITA

The November meeting of the Wichita Section was held on the 13th. The speaker of the evening was Mr. J. F. Lincoln, President of The Lincoln Electric Company, who spoke on "Welding Profits *versus* Prejudice" and his talk was accompanied by slides. There was an attendance of 98 people at this meeting, indicating that there is considerable interest in welding activities in this locality.

YORK-CENTRAL PENNSYLVANIA

Colonel G. F. Jenks, President of the AMERICAN WELDING SOCIETY, was the guest speaker at the October 10th meeting of this Section. Colonel Jenks first outlined the functions and studies of the Welding Research Committee of the Society. His chief topic for the evening talk was "Welding in National Defense." He gave some of the background of welded design so far as it applies to the Ordnance Department of the U. S. Army. His talk was well illustrated and very well received. A lively open forum period followed the presentation.

Officers for the fiscal year are: *Chairman*, E. J. Brady; *Vice-Chairman*, W. B. Lair; *Secretary*, C. B. Herrick; *Treasurer*, A. M. Ross; *Directors for two years*, J. W. Hennessey, C. C. Keyser, A. T. Light. *Director for one year*, A. B. Heilman.

Installation of new officers took place at the November 20th meeting, following which there was a "Weldformation Please" quiz. A board of experts composed of five members was as follows: E. J. Anderson, C. C. Keyser, W. E. Hollingshead, W. B. Lair and Bruce Petrikin. Several questions had been submitted previous to the meeting. These were relayed to the experts by M. J. Van Dreaser who served as the quizzer. A very interesting meeting followed. First the board members would discuss the question and then it would be thrown open for further questions or answers from the floor. Almost everyone took part in the program and there was a lot of lively discussion during the evening. Everyone agreed that the meeting was very successful and most beneficial.

YOUNGSTOWN

The meeting held October 15th was a huge success in every respect. It was attended by 116—49 members and 67 guests. Twenty-nine new members joined!

A ballot was used to determine the programs desired and to set the monthly meeting night. There was noted an outstanding interest in metallurgy of welding, and an endeavor will be made to have an outstanding speaker on this subject on the December program.

By having the members indicate their preference, programs of interest can be provided and, of course, by bringing the members as a whole into the picture of deciding the policy of the sectional activities, there is immediately secured a degree of cooperation that otherwise would not be possible.

Everyone attending the meeting was very enthusiastic about the start made, and a very successful year is indicated.

The December meeting of the Youngstown Section of the AMERICAN WELDING SOCIETY was held Tuesday, December 3rd. The Chairman opened the meeting and discussed the meetings to be held the remainder of the season. Program cards were given to all those present.

The first speaker of the evening, Dr. Comfort Adams, of the E. G. Budd Manufacturing Company, presented a very fine talk on "The World Today."

The Chairman of the Membership Committee reported on the work being done by this committee, and the two members themselves made personal reports on the work they are doing.

The second speaker of the evening was Mr. J. H. Cooper, of the Taylor-Winfield Corp., who gave an interesting discussion on the importance of the operator in steel fabrication. This was followed by an open discussion by all those present.

The meetings scheduled for the first half of 1941 are as follows:

Jan. 7th—"Your Defense Program," Col. G. F. Jenks, President, AMERICAN WELDING SOCIETY; "Arc Welding in the Fabrication of Steel," Leon C. Bibber, Carnegie-Illinois Steel Corp.

Feb. 4th—"The Metallurgy of Welding," Dr. J. C. Hodge, Vice-President, Wellman Eng. Co.

March 4th—"Machine Flame Cutting and Preparation for Welding," W. Roy Widdoes, Gen. Mgr., By-Products Steel Corp.; "Welding of Stainless Steel," R. D. Thomas, President, Arcos Corporation.

April 1st—"Looking Into the Future," J. W. Meadowcroft, Asst. Works Mgr., E. G. Budd Mfg. Co.; Plant Inspection—Federal Machine & Welder Co., Warren.

May 6th—"Flame Machining," J. G. Magraph, Air Reduction Sales Co.; "Flame Cutting," J. H. Zimmerman, The Linde Air Products Co.; "Flame Hardening," K. F. Schattel, National Cylinder Gas Co.; Election of Officers.

Employment Service Bulletin

SERVICES AVAILABLE

A-385. Welding Technician. 35 years of age. Twelve years' experience in a technical and supervisory capacity. Thoroughly familiar with training and qualification of welding operators, and all methods of Physical and Non-Destructive Testing. Also familiar with all modern methods of welding, including Flash Resistance Welding and the Unionmelt process.

A-386. Welder. 172 hours' training, Lincoln Electric Welding School. Grade good. High School and Trade School education; can read plans. Married. 33 years of age.

A-387. Welder. Would like position as gas welder in an airplane plant. Learned gas and electric welding at Acme Trade School. High school graduate. Also studied three years in Yale School of Music.

A-388. Industrial Engineer with 6 years' fusion welding experience as inspector, foreman and supervisor of welding. Familiar with all automatic and mechanical welding processes. Now employed as Welding Engineer and Estimator on Heavy Plate Fabrication. Seeks position where Industrial Engineering methods are to be applied to welding.

A-389. Electric Welder. Three years' experience. Graduate of N. Y. Trade School.

A-390. Graduate of New York Technical Institute. Would like position in welding field, preferably in aircraft work. Would be willing to go out of town.

A-391. Electric Welder. Has own A.C. Ampere welding machine. 31 years of age. Single. Willing to go anywhere.

A-392. Research and Testing Engineer available. Graduate of University of Texas, Degree C.E. 1912, M.S. University of Illinois, 1914. Long record of experience as Research Engineer, Engineer of Tests, Joint Committee on Stresses in Railroad Track, U. S. Shipping Board, University of Texas. 1928 to date Special Research Professor of Engineering Materials, University of Illinois. Several important publications.

A-393. Welder with more than five years' experience. Was gang foreman of fourteen welders (tanks) and was welding inspector at the same time. Passed Maritime test, Navy test, black steel and galvanized steel, also Navy test 25-20 chrome nickel test for welding armour plate on ships. Considered good welder in tight spots. Can weld in any position; water and air tight welding and can use many electrodes. Willing to take test at any time.

If you can use any of these men or have vacancies please notify the American Welding Society. There is no charge for this service either to employers seeking Welding Talent or Welding Experts seeking positions.

List of New Members

November 1st to November 30, 1940

BIRMINGHAM

Day, J. R. (C), Continental Gin Co., Birmingham, Ala.
Smith, James M. (C), 2400—1st Ave. No., Birmingham, Ala.
Taylor, Floyd E. (B), Box 186, Birmingham, Michigan.

BOSTON

De Forest, Alfred V. (B), Mass. Inst. of Tech., Cambridge, Mass.
Galantos, Paul V. (B), Arthur C. Harvey Co., 60 Everett St., Allston, Mass.
Galvin, George M. (D), New England Welding Labs., Inc., 88 St. Stephen St., Boston, Mass.
Stevick, Charles C. (F), 12 Sterling St., West Somerville, Mass.

CHATTANOOGA

Shipwash, Raymond (D), Margrave St., Harriman, Tenn.

CHICAGO

Auler, Edgar P. (C), 4530 N. Kasson Ave., Chicago, Ill.
Browning, W. B. (C), The Linde Air Prods. Co., 230 No. Michigan Ave., Chicago, Ill.
Casper, Edward A. (C), 1007 N. Lawler Ave., Chicago, Ill.
Kellogg, Harold V. (C), 1112 No. Christiana, Chicago, Ill.
Kenrick, Ralph S. (C), 14417 So. Michigan Ave., Riverdale, Ill.
Sokoloff, R. M. (D), 4649 W. Harrison St., Chicago, Ill.

CLEVELAND

Allison, Edwin F. (C), 3656 Latimore Rd., Shaker Heights, Ohio.
Hofstetter, Joseph W. (B), 620 E. 103rd St., Cleveland, Ohio.
Hull, Earl B. (B), Bureau of Marine Insp. & Nav., 408 Federal Bldg., Cleveland, Ohio.
Landrum, Robert J. (C), 13510 Woodworth Ave., Cleveland, Ohio.
Metzger, Ray W. (C), 4017 Payne Ave., Cleveland, Ohio.
Quist, Ralph H. (C), 4148 W. 49th St., Cleveland, Ohio.
Sprang, G. A. (B), 18209 Canterbury Rd., Cleveland, Ohio.
Twining, Edmund S., Jr. (C), Air Reduction Sales Co., 1210 W. 69th St., Cleveland, Ohio.

COLUMBUS

Clark, Wm. H. (B), Jeffrey Mfg. Co., Columbus, Ohio.
Derr, Charles H. (F), 414 N. Market St., Londonville, Ohio.
Hibbett, Harry (C), Osgood Company, Marion, Ohio.
Kelker, David R. (F), 132 N. Charles St., Lima, Ohio.
Kelker, John W., Jr. (F), 149 E. Frambes, Columbus, Ohio.
McDaniel, Thomas D. (F), 47 W. 9th Ave., Columbus, Ohio.
Waldvogel, Robert K. (F), 115 W. 11th Ave., Columbus, Ohio.
Wilson, Charles W. (F), 244 Kenwood Ave., Dayton, Ohio.

LOS ANGELES

Allen, Orville C. (C), 143 No. Herbert Ave., Los Angeles, Calif.
Fitch, Raymond L. (B), 827—4th St., Santa Monica, Calif.

MARYLAND

Klaunberg, Frederick H. (B), Riderwood, Maryland.

MILWAUKEE

Ahsinger, Louis (C), 2418 A West Galena St., Milwaukee, Wis.
Bauer, Walter L. (C), Geo. J. Meyer Mfg. Co., Cudahy, Wis.
Erickson, H. E. (C), Nordberg Mfg. Co., 3134 So. Lenox St., Milwaukee, Wis.
Fish, Raymond O. (C), 724—8th St., Beloit, Wis.
Gallo, Werner J. (C), 2333 No. Oakland Ave., Milwaukee, Wis.
Hart, Chauncy (C), 2130 No. 61st St., Milwaukee, Wis.
Knickelbine, Bert (C), 5270 No. 53rd St., Milwaukee, Wis.
Kottnauer, Robert (C), 1659 So. 30th St., Milwaukee, Wis.
Leiser, Fred (C), 3958 S. First Place, Milwaukee, Wis.
Messman, Randall (C), 2045 S. 68th St., West Allis, Wis.
Mitchell, Walter I. (D), 1143 Harrison Ave., Beloit, Wis.
Port, Fred G. (C), 4349 No. 18th St., Milwaukee, Wis.
Rosenberg, Edwin C. (C), 3356 N. Humboldt Ave., Milwaukee, Wis.
Scheil, Merrill A. (C), A. O. Smith Corp., Milwaukee, Wis.
Stein, Harold J. (B), Allis-Chalmers Mfg. Co., West Allis, Wis.
Thompson, Edw. B. (C), 6927 Wellauer Ave., Wauwatosa, Wis.
Weber, Arthur E. (C), 3622 E. Edgerton Ave., Cudahy, Wis.
Zeh, Ray (C), 2121 E. Capitol Dr., Milwaukee, Wis.

NEW YORK

Booth, Murray C. (D), 76 Van Wagenen St., Jersey City, N. J.
Dinger, John (C), Atlantic Welding Co., 1027 Atlantic Ave., Brooklyn, N. Y.
Dunn, Ned (C), Dunn's Welding School, 1153 Atlantic Ave., Brooklyn, N. Y.
Ferguson, Robert M. (D), 32-34 35th St., Astoria, L. I., N. Y.
Fontana, Peter (D), 537-78th St., North Bergen, N. J.
Gill, Stanley (B), Taylor Forge & Pipe Works, 50 Church St., New York City, N. Y.
Krefeld, William J. (B), Columbia University, 317 Engineering Bldg., New York City, N. Y.
Loggin, Peter G. (D), 148 W. 14th St., New York, City, N. Y.
Pollock, John (D), 649—47th St., Brooklyn, N. Y.
Riotto, Santo J. (D), 4414—10th Ave., Brooklyn, N. Y.
Schumacher, Frank (D), E. R. Merrill Spring Co., 532 W. 28th St., New York City, N. Y.
Van Derbeck, William A. (D), 178 Nevins St., Brooklyn, N. Y.

NORTHERN NEW JERSEY

Baker, James (D), 160 Van Nostrand Ave., Jersey City, N. J.
Cantelmo, Peter (D), 1087 Bromley Ave., W. Englewood, N. J.
Evans, Henry (D), R.F.D. 1, Dover, N. J.
Gormley, George E., Jr. (D), 85 Sussex Ave., East Orange, N. J.
Hoch, John H. (D), 308 Valley Brook Ave., Lyndhurst, N. J.
Holtz, Irving (B), Holtz Welding Inst., 786 Communipaw Ave., Jersey City, N. J.
Mathias, David L. (B), 98 Elliott Place, E. Orange, N. J.
McGinness, Francis V. (B), P.O. Box 296, Amityville, N. Y.
McGuinn, C. D. (C), National Cylinder Gas Co., 2136-46 85th St., North Bergen, N. J.
Morris, S. G. (C), % Lincoln Elec. Co., 330 W. 42nd St., New York City, N. Y.
Schriefer, Harry (C), Standard Welding & Spring Co., 744-48 Comminipaw Ave., Jersey City, N. J.
Skarzenski, Stanley (D), 199 Columbia Ave., Jersey City, N. J.
Stortz, Harry W. (B), 174 Renshaw Ave., E. Orange, N. J.
Watson, George J. (D), 12 Fairview Ave., Jersey City, N. J.

NORTHWEST

Canfield, Norwood N. (B), 3313—44th Ave., So., Minneapolis, Minn.
Mealey, Albert J. (B), 1810 Bryant Ave., So., Minneapolis, Minn.

OKLAHOMA CITY

Craig, James (B), % Black, Sivalls & Bryson, Oklahoma City, Okla.
Medley, E. G. (B), % Southwest Factory, 1428 W. Main St., Oklahoma City, Okla.
Page, B. J. (B), Scott & Page Body Works, 924 W. Calif., Oklahoma City, Okla.
Reid, Charles D. (C), Oklahoma Gas & Elec. Co., Horseshoe Lake Sta., Harrah, Okla.

PHILADELPHIA

Goodsell, Earl (C), Brushtown Road, Ambler, Pa.
Lang, Paul (C), Box 115, Downington, Pa.
Tovey, Alfred W. (D), 422 Center St., Bethlehem, Pa.

PITTSBURGH

Hull, Curtis R. (C), Fair Oaks, Pa.
McLean, William B. (C), 230 Chestnut St., Sewickley, Pa.
Willard, John N. (C), 344 Amber St., Pittsburgh, Pa., East End.
Williams, C. H. (C), Jourden Technical School, 5746–48 Baum Blvd., Pittsburgh, Pa.

PUGET SOUND

Long, Howard W. (B), 7708—1st Ave., N. E., Seattle, Washington.

ROCHESTER

Comisso, Frank (D), 10 High St., Pittsford, N. Y.
Schoeffler, William (D), 205 Reynolds St., Rochester, N. Y.
Van Epps, Walter L. (D), 89 Ontario View St., Charlotte Station, N. Y.
Wuerstle, James M. (D), 474 Maplewood Ave., Rochester, N. Y.

ST. LOUIS

Kroeger, A. (C), 8024 Monroe, St. Louis, Mo.

SAN FRANCISCO

Nelson, Ted (C), 1926 Marin St., Vallejo, Calif.
Pedrizzetti, Anthony C. (C), Box 236, Concord, Calif.

SOUTH TEXAS

Buenger, O. C., Jr. (D), 107 E. Ninth St., Houston, Texas.
Chester, D. (C), P.O. Box 92, Mederland, Texas.
McCoy, Wilson B. (C), Turnersville, Texas.

WESTERN NEW YORK

Brooks, William C. (B), Niagara Alkali Co., Niagara Falls, N. Y.
Winter, O. W. (C), Sandy Beach, Grand Island, N. Y.

WICHITA

Coppenbarger, Orville C. (D), 1957 S. St. Francis, Wichita, Kansas.
Crole, Lawrence (D), 331 N. Seneca, Wichita, Kansas.
Hiebert, D. J. (D), O.K. Boiler & Welding Works, Chase, Kansas.
Looney, James P. (C), Watkins, Inc., 710 E. First St., Wichita, Kansas.
Perdew, W. E. (C), Winkler-Koch Engineering Co., 335 W. Lewis, Wichita, Kansas.

YORK—CENTRAL PA.

Burket, Adam H. (D), 44 W. Liberty St., Lancaster, Pa.

YOUNGSTOWN

Anderson, Robert (C), 1324 South St., S. E., Warren, Ohio.
Beaver, Wallace W. (C), 404 High, N. E., Warren, Ohio.
Coates, C. E. (C), 616 Woodbine, S. E., Warren, Ohio.
Coleman, L. A. (C), 606 E. Liberty St., Hubbard, Ohio.
Conklin, Leroy R. (C), Phalanx Sta., Ohio.
Cooper, Ralph F. (C), 149 Perkinswood Blvd., S. E., Warren, Ohio.
Forkner, E. W. (C), 334 Oak Knoll Ave., S. E., Warren, Ohio.
Giesey, Boyd V. (C), 336 Iddings, S. E., Warren, Ohio.
Hageman, George J. (C), 2018 Market St., Youngstown, Ohio.
Hansen, Hans (C), 253 Lowell Ave., Warren, Ohio.
Hayes, Bert (C), 901 Francis Ave., S. E., Warren, Ohio.
Jordan, W. H. (C), 907 Adelaide S. E., Warren, Ohio.
McGill, C. E. (C), P.O Box 682, Greenville, Pa.
Rhinehart, Henry A. (D), P.O. Box 312, Fredonia, Pa.
Ross, L. P. (C), R.D. 4, Greenville, Pa.
Ross, Richard L. (D), R.F.D. 4, Greenville, Pa.
Seeloff, Melvin (C), Taylor-Winfield Corp., Warren, Ohio.
Seltzer, C. S. (C), Taylor-Winfield Corp., Warren, Ohio.
Simmons, Oscar B., Jr. (C), 471 Washington St., N. E., Warren, Ohio.
Sirabian, E. A. (C), 405 Oak Knoll Ave., S. E., Warren, Ohio.
Stone, Willard (C), R.R. 4, Warren, Ohio.
Taylor, William M. (D), 1916 Niles Ave., Warren, Ohio.
Tilsher, Warner G. (C), 1748 Parkman Rd., N. W., Warren, Ohio.
Wangen, Norman (C), Taylor-Winfield Corp., Warren, Ohio.
Watson, W. E. (C), Taylor-Winfield Corp., Warren, Ohio.
Whalen, Floyd (C), Taylor-Winfield Corp., Warren, Ohio.

NOT IN SECTIONS

Edwards, L. Harry (D), Bethel, Alaska.
Hebden, John W. (C), L & N Railroad Co., South Louisville Shops, Louisville, Ky.
Lewis, Fred W. (D), 57 Young St., Halifax, Nova Scotia.
Ohtsuka, Seishi (B), Japanese Welding Soc., Makicho Building, Edobashi, Nihonbashiku, Tokyo, Japan.
Payne, Vincent (C), 428 No. 20th St., Louisville, Ky.

APPOINTMENT SECTION ADVISORY COMMITTEE

The Executive Committee of the AMERICAN WELDING SOCIETY, at its meeting on December 12th, acted favorably upon the recommendation of the Section Officers for the appointment of a Section Advisory Committee to serve in the capacity of liaison officer between the National Board of Directors and the Sections. The organization and specific functions of the Committee are given below.

With the approval of the Board of Directors, President Jenks named the following members of this committee.

For term ending October 1943:
- K. L. Hansen, Chairman, Harnischfeger Corporation, Milwaukee
- A. J. Moses, Hedges-Walsh-Weidner Div., Combustion Eng. Co., Chattanooga, Tenn.

For term ending October 1942:
- Prof. W. F. Hess, Rensselaer Polytechnic Institute, Troy, N. Y.
- F. C. Fantz, Midwest Piping & Supply Co., St. Louis, Missouri

For term ending October 1941:
- F. L. Plummer, Hammond Iron Works, Warren, Pennsylvania
- T. C. Smith, General Petroleum Corp., Los Angeles, Calif.

Organization and Functions Section Advisory Committee, American Welding Society

The Section Advisory Committee shall consist of six members of the SOCIETY who are not at the time of their appointment elected Directors.

Two members of the Committee shall be appointed for a term of one year, two for a term of two years, and two for a term of three years; two new members being appointed each year for a term of three years, it being understood that no member can be reappointed until at least one year has elapsed after the completion of his last term.

This Committee shall act in an advisory capacity to the Board of Directors in all matters pertaining to the activities of the Sections of the SOCIETY and shall be responsible for planning and conducting the Section Officers' Conferences.

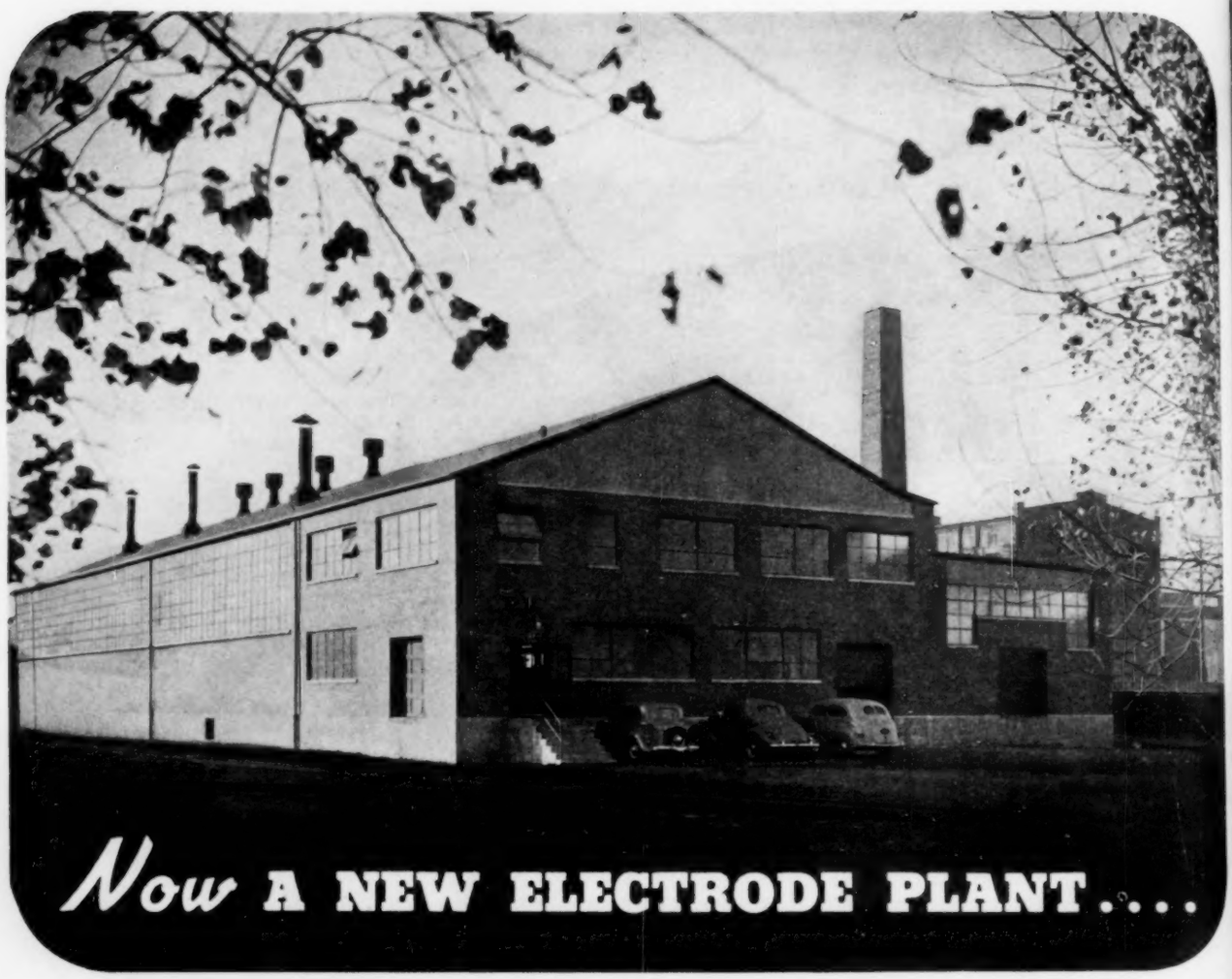
District Vice-Presidents who are however members of the Board of Directors shall be eligible to serve on the Section Advisory Committee. The Committee shall be set up as a rotating committee so as to provide continuity and insure the bringing in of new life and new ideas.

GLOSSARY OF METALLOGRAPHIC TERMS

A "Glossary of Metallographic Terms" by J. Neill Greenwood, D.Sc., M.Met.E., Professor Metallurgy, University of Melbourne, Australia, has just been published by The Tait Publishing Co. Pty. Ltd. Agents in this country are Messrs. G. E. Stechert & Co., 31–37 East 10th Street, New York. Price $1.50.

This glossary is intended primarily for students of metallography who, at the beginning of their studies, are confronted with many new terms, some of which have more than one meaning. At the same time, it is thought that it will prove useful to a wider range of students, who need to know something of metallography and yet have neither the time nor the opportunity for a full study of the subject.

There is, however, particularly at the present time of national crisis, a much wider section of the community interested in the utilization of metals, to whom it is hoped this glossary will be useful. Engineers, inspectors and craftsmen are confronted with the vast accumulated knowledge of the past twenty years, and anybody who would read recent metallurgical literature must needs use a key.



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